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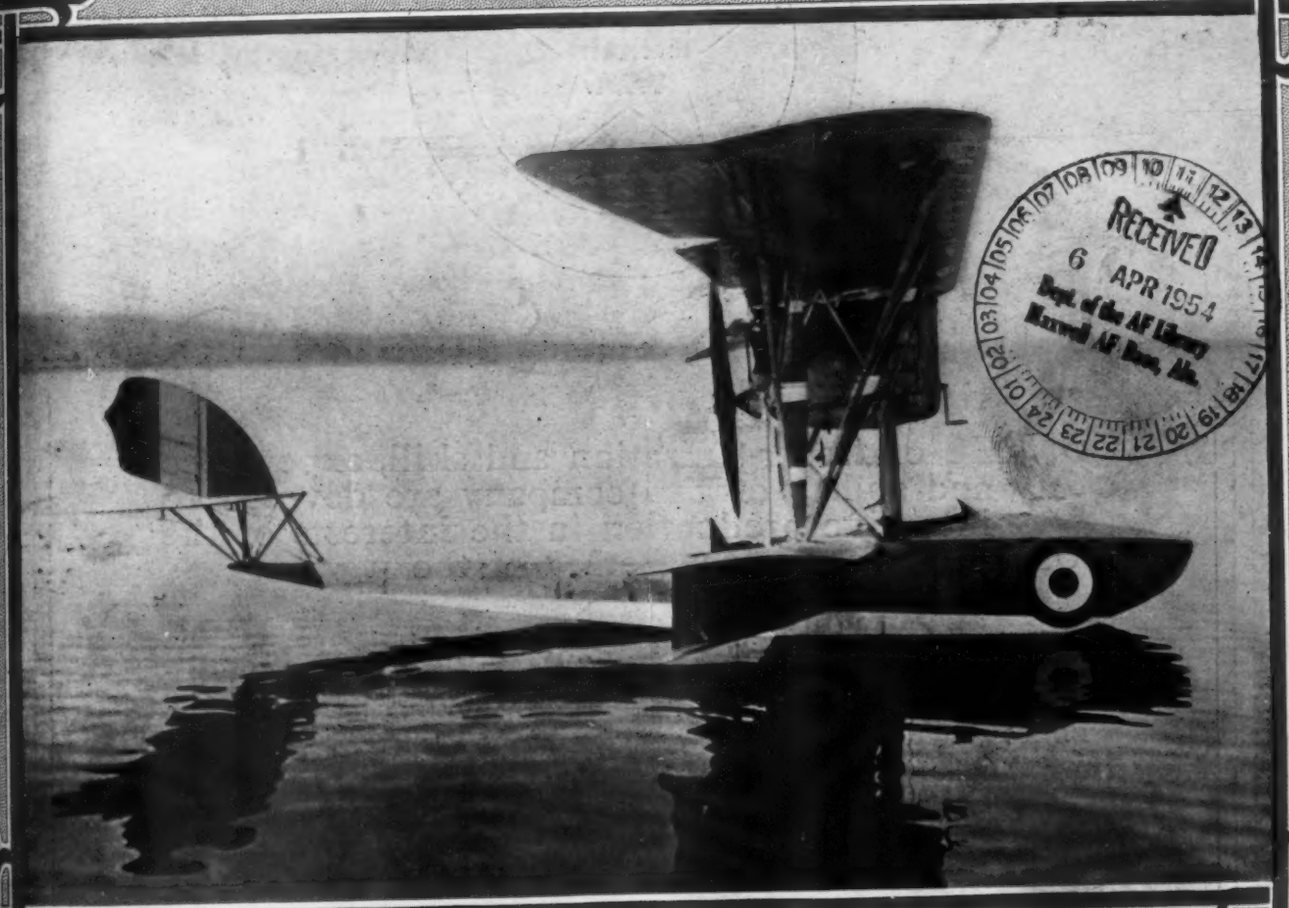

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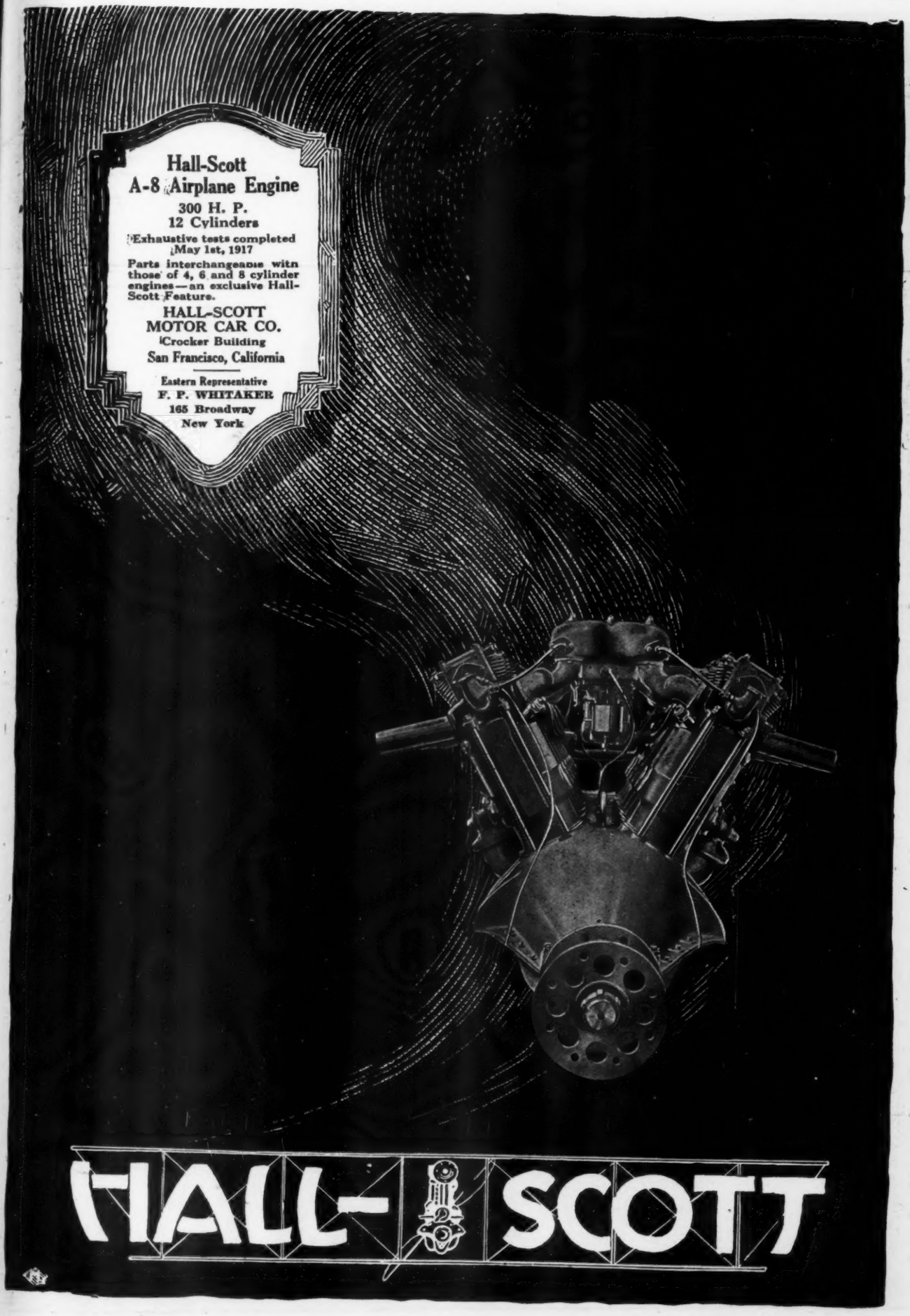
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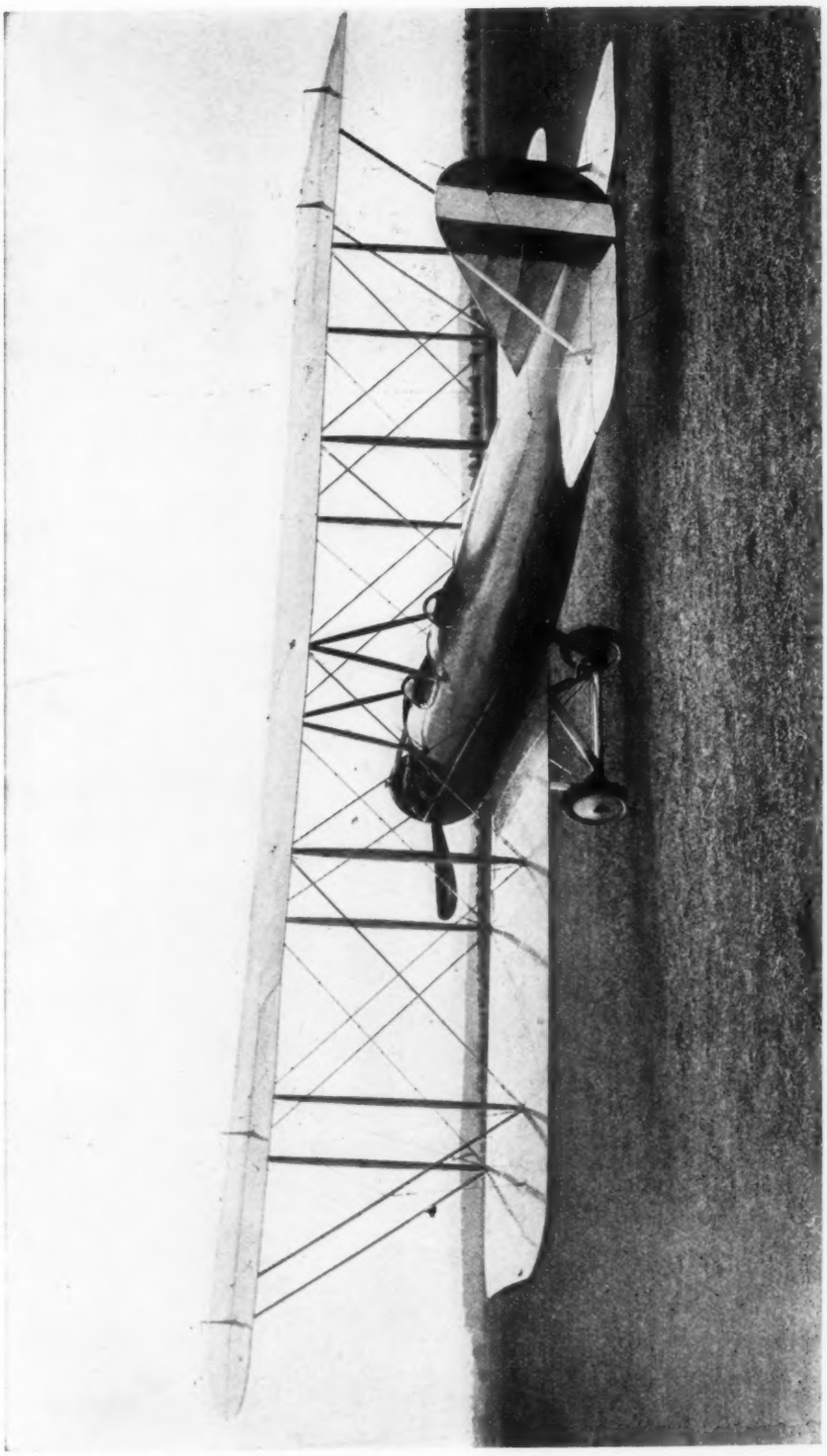

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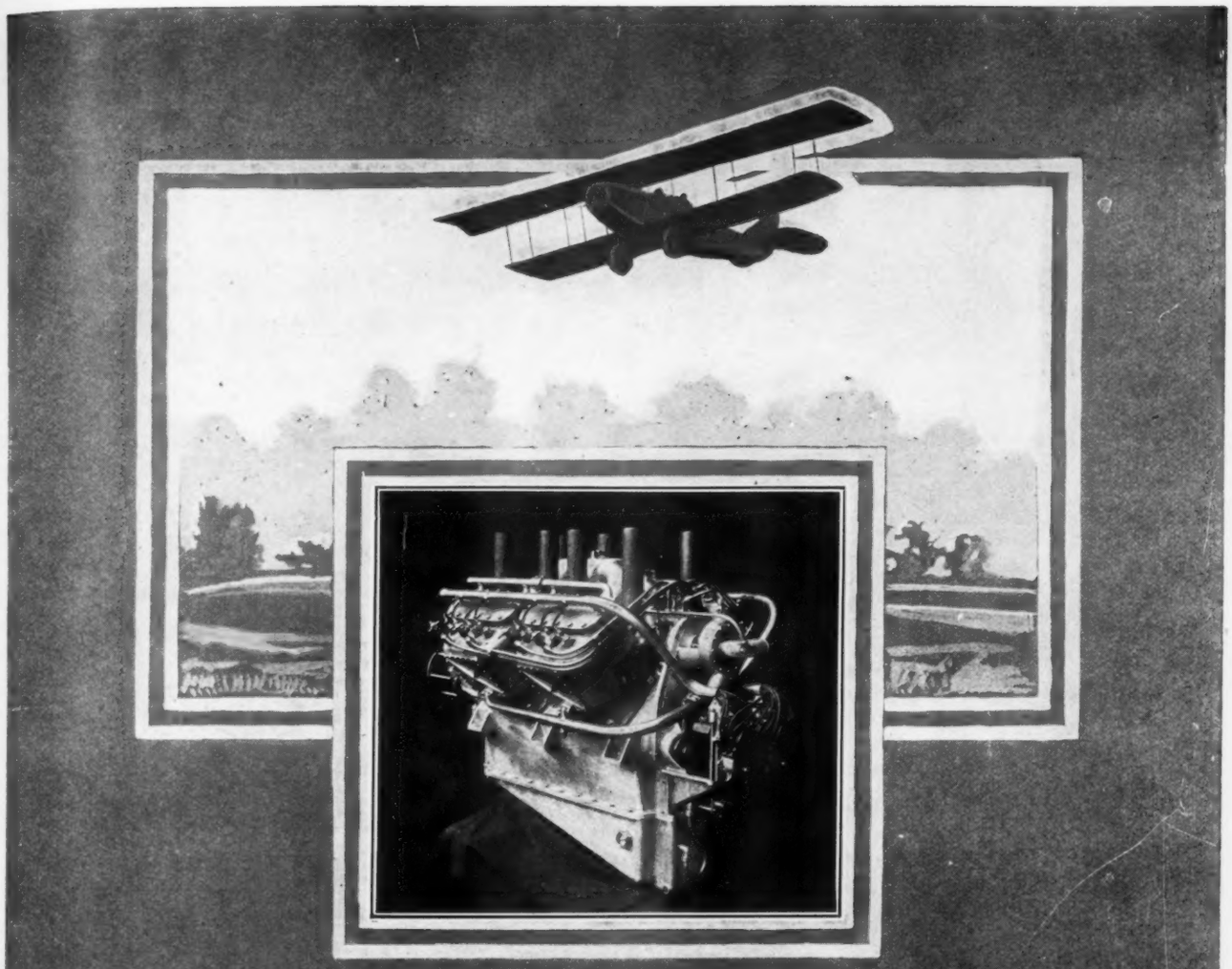

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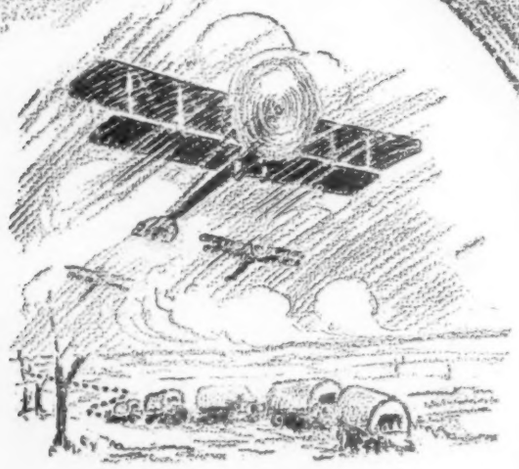

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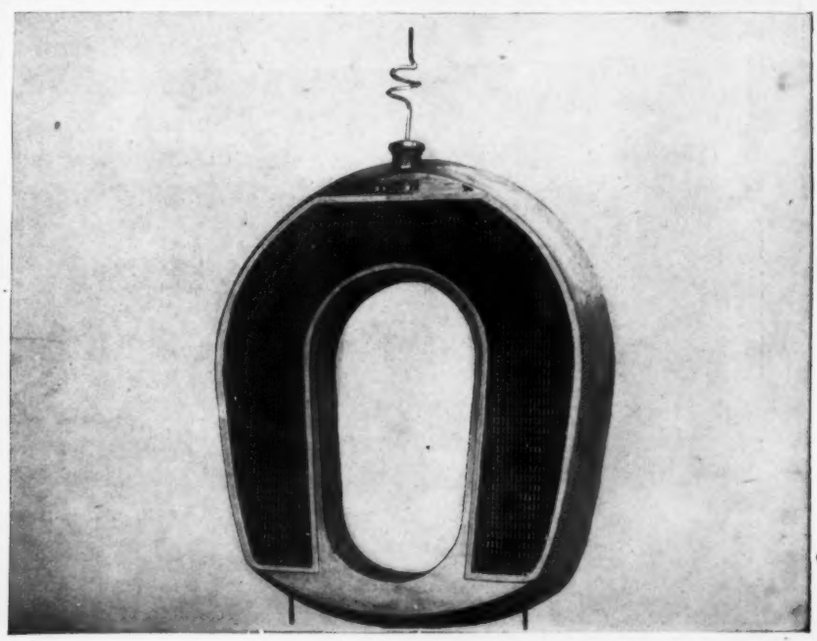

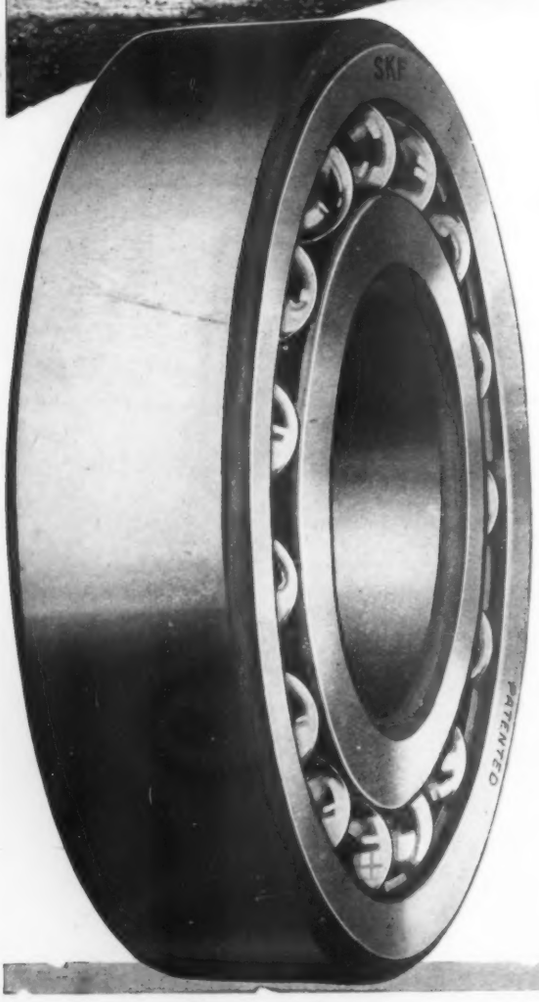

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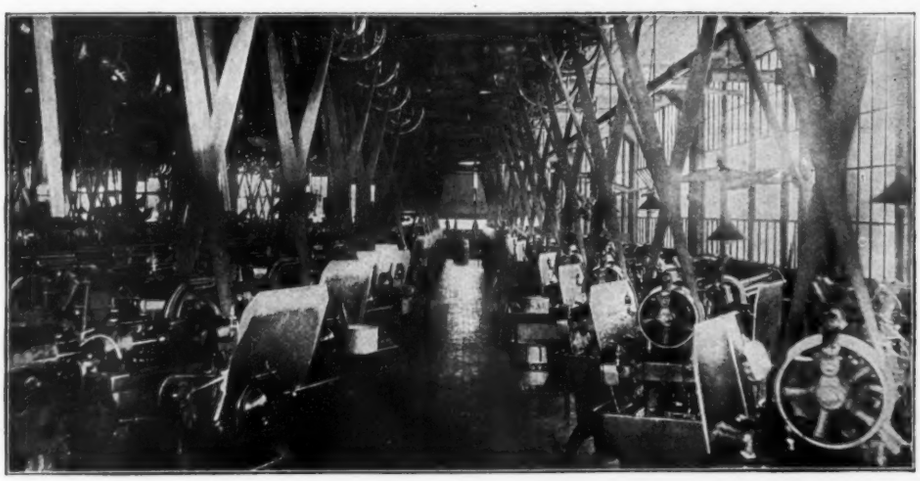

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Liabilities	9,190,793.64
Net Surplus	4,232,068.87
Capital	2,000,000,00
Net Surplus to Policyholders	6,232,068.87

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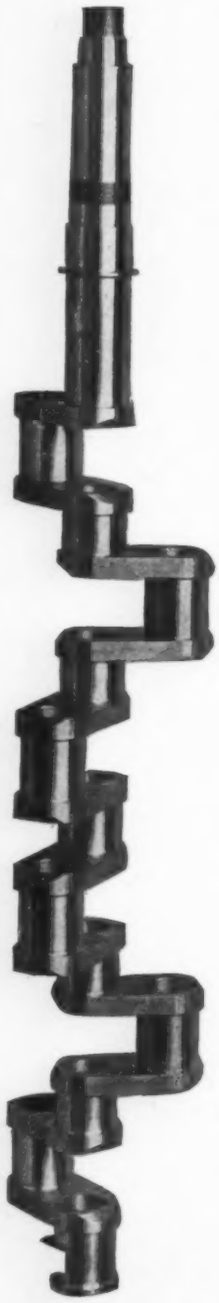

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MARCH 15, 1918

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. IV. NO. 4

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INDEX TO CONTENTS

	PAGE
Physical Properties of Airplane Woods	223
The Model C. IV Rumpler Biplane	226
Curtiss Is Granted Flying Boat Patent	228
The Medical Aspects of Airplane Accidents	232
Book Review	235
International Aircraft Standards	236
Digest of the Foreign Aeronautical Press	239
Plans for the Aerial Mail	240
News of the Fortnight	241

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God bless my brother gone to war
Across the seas, in France, so far.
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Vol. IV | March 15, 1918 | No. 4

Physical Properties of Airplane Woods

By C. H. Congdon, M.E.

The principal object of this article is to clear up several points concerning the strength and elasticity of woods used in airplane construction as affected by various agents which will be enumerated later and taken up in the order of their importance.

It would be useless to go into detail with each species because each requires a separate treatment and has different properties,

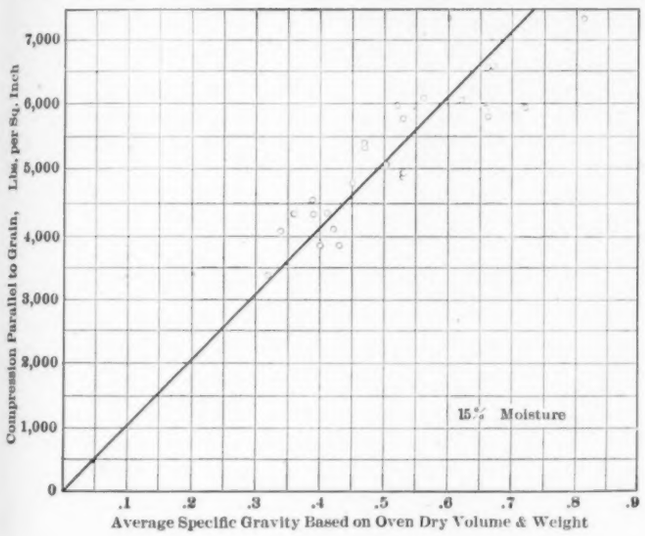


FIG. 1

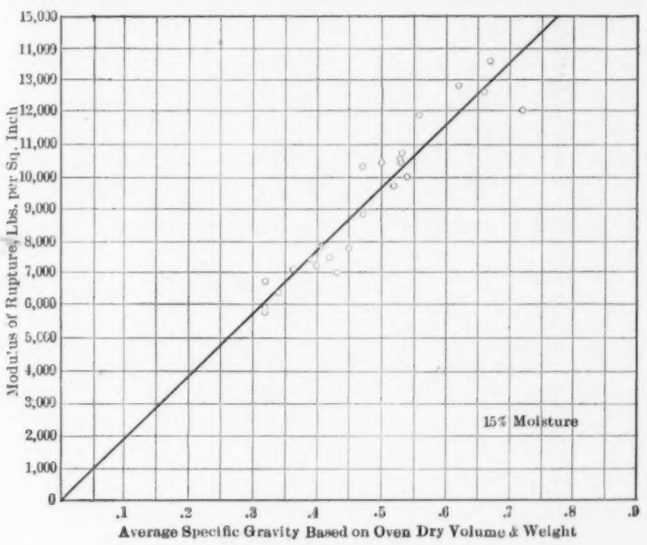


FIG. 2

which, while affected by the same agents, are not affected in the same degree. For this reason the three species most commonly used in airplane construction will be discussed—spruce, ash and white pine.

In airplane construction a wood is desired that possesses the properties of lightness, high moduli of rupture and elasticity, moderate hardness and freedom from brash.

In wing spars the stresses induced are due to a combination of either flexure and direct compression or flexure and tension. The resulting compression or tension is generally taken as the algebraic sum of the stresses induced by the drift and lift loads. The hardness and shearing strength parallel to the grain are also of importance; because, if a soft wood is employed having low resistance to horizontal shear, it becomes necessary to use spar fittings having a large bearing surface to prevent mashing and a wide spar section to guard against failure due to horizontal shear.

Spruce has given the most satisfactory results when used for the stressed members of airplanes. White pine has a slightly lower specific gravity than spruce but is inferior for stressed members, because of its comparative softness and brashness. The compressive strength of pine is slightly higher than that of spruce but the moduli of rupture and elasticity are slightly below. If the only consideration entering into the selection of pine or spruce for wing spars rested on the flexural and compressive strengths, either wood should be expected to give satisfactory service. As mentioned before, the consideration of hardness and shearing strength parallel to the grain plays an important part.

In the case of struts, most of which are long columns, the modulus of elasticity is the deciding factor, and here again spruce shows its superiority.

The comparison of ash with spruce from the standpoint of their respective flexural strengths results in favor of ash for the same weight, and the latter has a higher resistance to crushing. These two considerations would seem to indicate that ash would be superior for wing spars. In comparing two wing spars, one of ash and one of spruce, the variable dimension will be the width. The deflection of an ash spar will, for the same load, be greater than that of the spruce spar. As a matter of fact, the increase in deflection of the ash spar over the spruce spar of the same strength will be about 39 per cent. In substituting an ash beam the efficiency is lowered and all the dangers incident to deformation of the wing structure as a whole are increased. The spruce spar having a greater thickness, facilitates the fastening of strut sockets, hinges, etc., on it, and more nearly equalizes the strength in both the vertical and longitudinal planes.

Strength Variation

In all species there is a difference in strength in wood from different positions of the tree and from different localities of growth. The importance of these variations has been overestimated however, and it is not considered worth while going into them. Differences in strength are mainly due to variations in the specific gravity and moisture content.

The specific gravity affords an approximate but direct measure of the strength irrespective of the species. Figs. 1, 2 and 3 show how the strength in compression, the modulus of rupture, and the modulus of elasticity vary with the specific gravity. These curves were plotted using values from tests

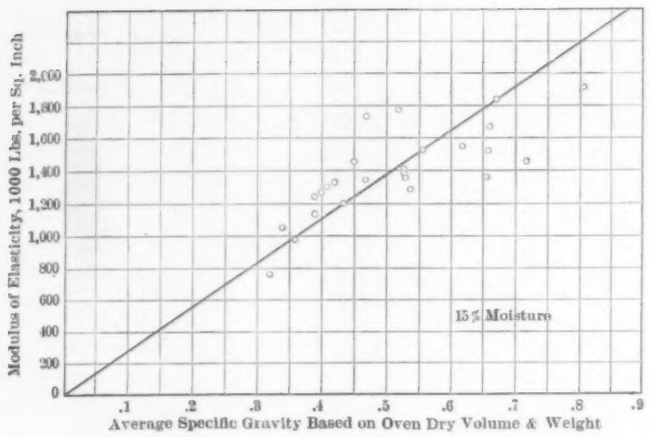


FIG. 3

made at the Forest Products Laboratory at Madison, Wisc. The tests included twenty-six species of woods. Since these curves represent an average, they are useful in comparing a specific wood to see whether it falls above or below the curve and is, consequently, above or below the average in strength or elasticity for its weight.

Effect of Moisture Content

Up to the fiber saturation point—the point at which maximum absorption by the cell walls occurs—wood changes very markedly in its mechanical properties. As shown in Figs. 4, 5 and 6, the strength and elasticity decrease rapidly at first as the moisture content increases, but decrease more slowly to the fiber saturation point, after which they remain constant.

Comparison of Tables

A great deal of confusion has resulted in the comparison of strength tables compiled from tests made by various individuals and companies. Most available tables of strengths for woods make no mention of the amount of moisture present in the test pieces or the specific gravities of the woods. More frequently there is no description given, even briefly, of the conditions under which the tests were made or of the sizes of the pieces tested. It is absolutely useless to compare tables unless the tests were made under similar conditions. However, conversion factors may be employed in a great many cases for transfer of moisture content and specific gravity and a fair comparison will result. There is no direct method of correcting the discrepancy that results in varying conditions, consequently only an approximate agreement of different tests can be expected after the moisture and specific gravity corrections have been made.

Physical Tests

In order to make wood tests for strength and elasticity complete, the moisture and specific gravity determinations should be made in addition to the customary mechanical tests. These determinations serve as a check on each other, and the absence of any one makes the result questionable. It has been suggested that the specific gravity determination be the only one made for strength. Even though the strength is directly proportional to the specific gravity, it hardly seems reasonable to judge a wood entirely by its weight. The determination of the specific gravity can, however, be used to serve as a check when it is impracticable to make a series of complete tests on a lot of lumber. The specific gravity determination is the most reliable next to actual mechanical tests. One or two complete sets of tests could be made by selecting test specimens at random, and a check record on similar material be kept by making frequent specific gravity determinations. It should be borne in mind when making specific gravity determinations that the weight of wood in a given volume changes with shrinkage and swelling caused by changes in moisture. Consequently the determination for specific gravity should always be made under similar conditions in order to make the basis of comparison consistent.

Determination of Moisture Content

The moisture content is the weight of water contained in the wood, expressed in percent of the oven-dry weight of the wood. The moisture content is determined by weighing a small section of the test specimen and then drying at 100 deg. C. in freely circulating air until its weight becomes constant. The loss in weight is then divided by the dry weight to give the percent moisture which is generally given as a percentage

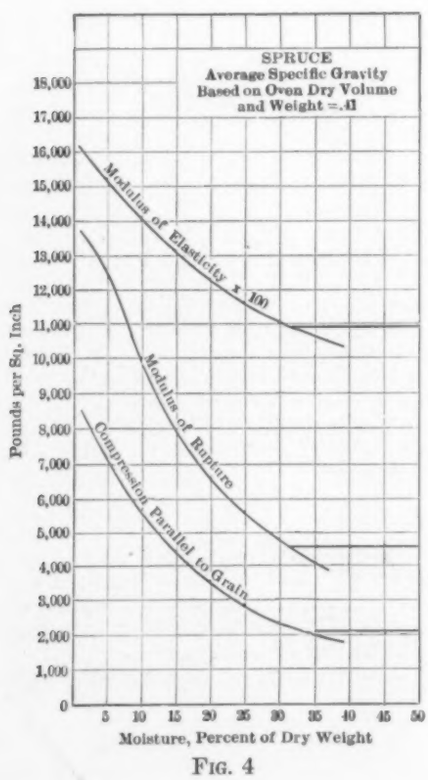


FIG. 4

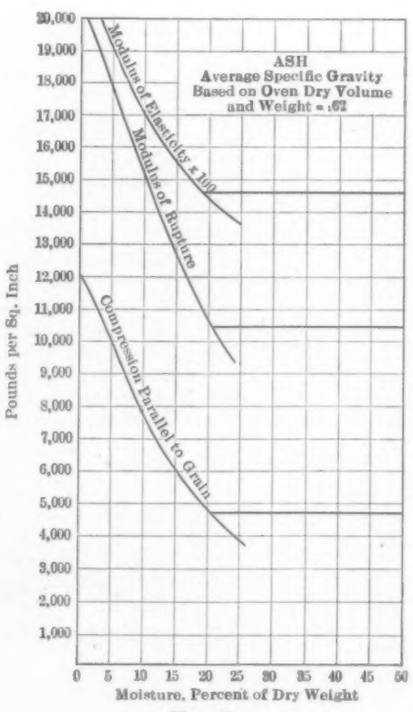


FIG. 5

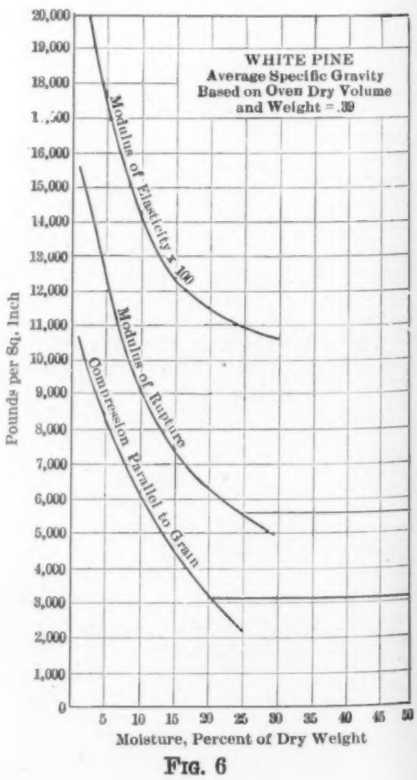


FIG. 6

of the dry weight. This determination will include any substance besides water which is volatile at 100 deg. C. In order to save time in making the determination the piece selected should not be longer than about one inch in the direction of the grain. This will facilitate the drying. The total volume should be between two and twenty-four cubic inches.

Determination of Specific Gravity

If the moisture determination is made it only becomes necessary to obtain the volume of the specimen. This is best done by measurement. If the moisture determination is not made the volume of the specimen should be obtained and also its dry weight. The latter is obtained as explained before. The specific gravity may be based on the volume at test, or on the oven-dry volume. The latter is the conventional method.

Standard Mechanical Tests

It is the opinion of the writer that much of the present confusion in interpreting test results and the general skepticism existing of accepting strength values given in available tables could be cleared up by establishing a set of standards for testing and noting any divergence from the standard procedure. With this thought in mind it seems desirable to include the following information regarding the mechanical testing of wood as carried on at the Forest Products Laboratory:

Static Bending

The test specimen used is 2 in. x 2 in. x 30 in. and is loaded at the center having a span of 28 in. The load is applied at a constant rate, simultaneous readings of load and deflection being taken.

Compression Parallel to Grain

The test piece is 2 in. x 2 in. x 8 in. and is compressed in the direction of its length. Deformation is measured between two collars 6 in. apart attached to the specimen.

Compression Perpendicular to Grain

The test piece is 2 in. x 2 in. x 6 in. long and is laid upon its side. The pressure is applied through a suitable hard metal plate 2 in. wide laid across the center of the piece and at right angles to its length. But one-third of the surface is directly subjected to compression.

Hardness

Hardness is tested by measuring the load required to embed a 0.444 in. ball to one-half its diameter in the wood.

Shearing Strength Parallel to Grain

The shearing test is made by applying force to a 2 by 2 in. lip projecting from the side of a block.

A more convenient method of determining the shearing strength when using a testing machine would be as follows: Select a test piece 2 in. by 2 in. by 12 in. Saw two slots in opposite sides two inches apart to a depth of one inch each. The test piece will then shear parallel to the grain over an area of four square inches between the slots when pulled as in a tension test.

Formulae Used in Computing

A = Area of cross section in sq. in.
B = Area under plate in compression perpendicular to grain tests in sq. in.
CS = Crushing Strength in lb. per sq. in.
E = Modulus of Elasticity in lb. per sq. in.
EL = Fibre Stress at elastic limit in lb. per sq. in.
J = Greatest calculated longitudinal shear in lb. per sq. in.
K = Constant = 27.7 when weight is in lb.; 0.061 when weight is in grams.
MR = Modulus of rupture in lb. per sq. in.
P = Maximum load in lb.
P^1 = Load at elastic limit in lb.
S = Dry specific gravity.
$\triangle$ = Total deflection or compression at elastic limit in inches.
b = Width in inches.
d = Distance between centers of collars in inches.
h = Height in inches.
l = Span in inches.

Bending

Load applied at center.

$$J = \frac{0.75 \times P}{b \times h}$$

$$MR = \frac{1.5 \times P \times 1}{b \times h^x}$$

$$E = \frac{P^1 \times l^3}{4 \times b \times h^3 \times \triangle}$$

Compression Parallel to Grain

$$CS = \frac{P}{A}$$

$$E = \frac{P^1 \times d}{A \times \triangle}$$

Compression Perpendicular to Grain

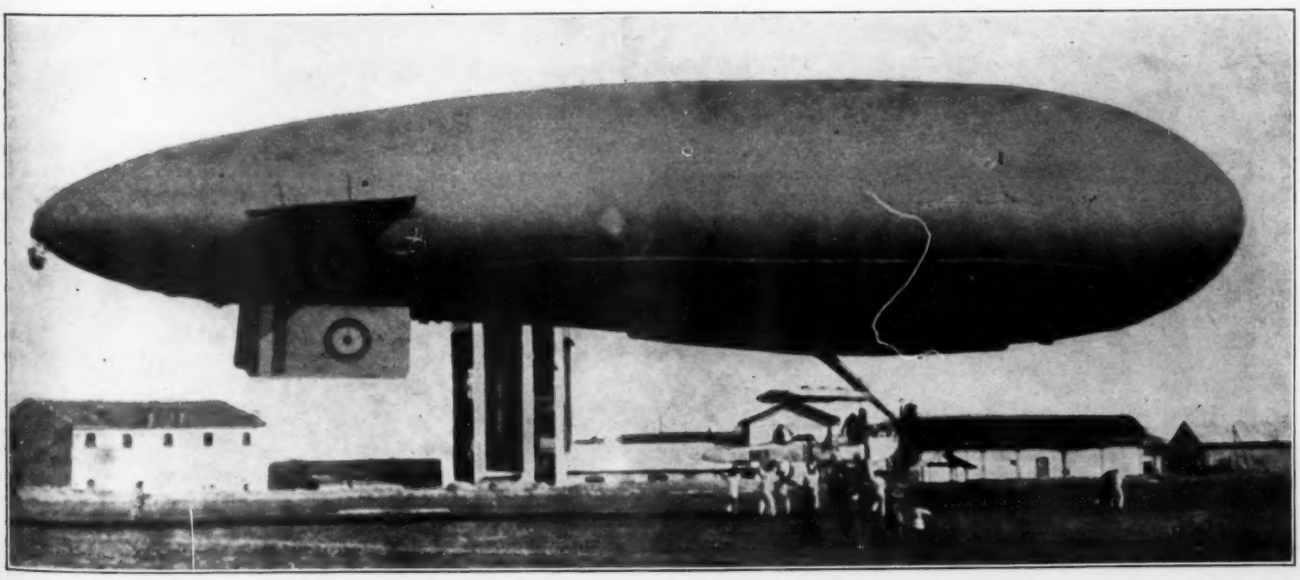
$$EL = \frac{P^1}{B}$$

Shear Parallel to Grain

$$\text{Shear} = \frac{P}{A}$$

Specific Gravity

$$S = \frac{\text{Weight} \times K}{\left(1 + \frac{\%\ \text{moisture}}{100}\right) \times \text{volumes of piece in cu. in.}}$$



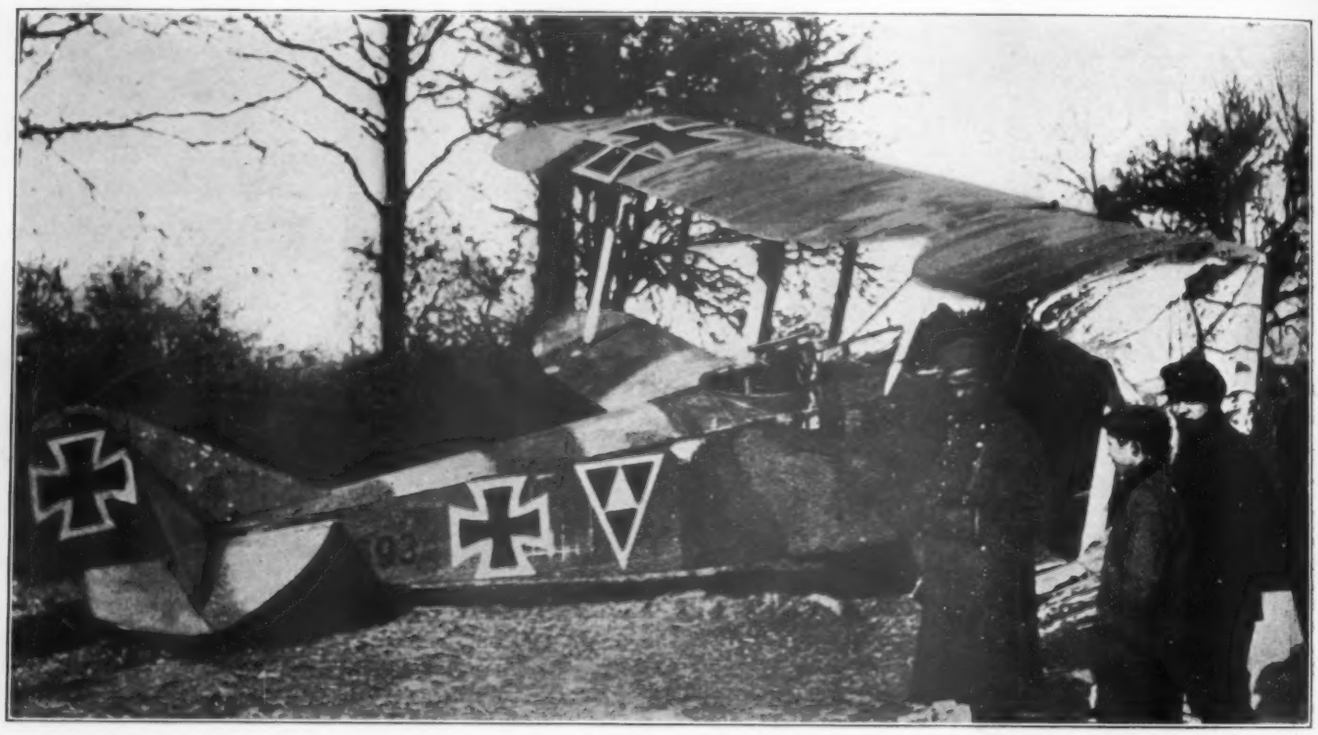
ITALIAN VERSION OF A "BLIMP"

(C) *Western Newspaper Union*

The Model C. IV Rumpler Biplane*

The Model C. IV Rumpler biplane belongs to the so-called "all-purposes," or general utility class of enemy machines, which may indiscriminately be employed for scouting, offensive patrol, bombing, etc.

This machine is chiefly of interest on account of its great speed, which is equal to that of a single-seater fighter, and also on account of its high "ceiling" (6.500 m.). This ability of reaching high altitudes has led the German air service to adopt a special respirator which has been issued only of late. The climbing speed of the Rumpler C. IV is also very good, being 5,000 m. in 35 minutes. Taken as whole, the machine possesses many points of similarity with the Rumpler C. III, fitted with a 160 h.p. Mercédès engine, and differs from the latter chiefly on account of its greater size. The difference in size is not, however, very noticeable, as may be seen from the comparative table shown below:



A Rumpler C.IV Which Was Brought Down in France
(C) *Underwood and Underwood*

COMPARATIVE TABLE

	Rumpler C. III.	Rumpler C. IV.
Span, upper plane	12.25 m.	12.60 m.
Span, lower plane	11.05 m.	12.10 m.
Overall length	7.90 m.	8.40 m.
Overall height	3.20 m.	3.25 m.
Weight, net	828 kg.	1,010 kg.

The Wings.—Both the upper and the lower wings have a retreat of 3 deg. and a dihedral of 2 deg. One captured machine of this model had, however, a dihedral of 2¾ deg. The wings are staggered, with the upper plane 0.60 m. forward of the lower plane. Contrary to German practice the trailing edge is rigid. The angle of incidence is, on one type, uniformly 5 deg., while on another type rib No. 1 (near the body) is set at 3 deg., rib No. 5 at 5 deg., rib No. 11 at 4¾ deg., and rib No. 14 at 4¼ deg. Maximum incidence is thus at about one-third span of each wing panel, counting from the body.

The upper wings are of trapezoidal shape, with rounded corners, and are cut out for visibility above the body. The maximum chord is 1.70 m., and the interplane gap, which is uniform, is 1.85 m. Each upper wing panel contains nineteen ribs and five compression members of steel tubing besides the two standard wing spars. The chord of the ailerons varies from 0.50 m. at the inner end, to 0.65 m. at the outer end; their overall length is 2.70 m.

The lower wings have rounded tips, such as are found on many German machines, the D. F. W. for instance, and have a certain resemblance with the blade of an airscrew, because the radius of the arc forming the trailing edge is greater than that of the leading edge. Each wing panel has seventeen ribs and four compression members of steel tubing.

The ribs are made of three-ply wood and are cut out for lightness. A narrow "running board," to use an automobile term, is built up of three-ply wood on either wing panel near the body.

There are two pairs of interplane struts on either side of the body; these are slightly inclined and strictly parallel to one another. Their dimensions vary, however, for the inner front struts measure in section 0.105 m., the inner rear struts, 0.130 m., the outer front struts, 0.090 m., and the outer rear struts, 0.085 m. This arrangement is undoubtedly due to the peculiar variations of incidence noted above on one type of the Rumpler C. IV.

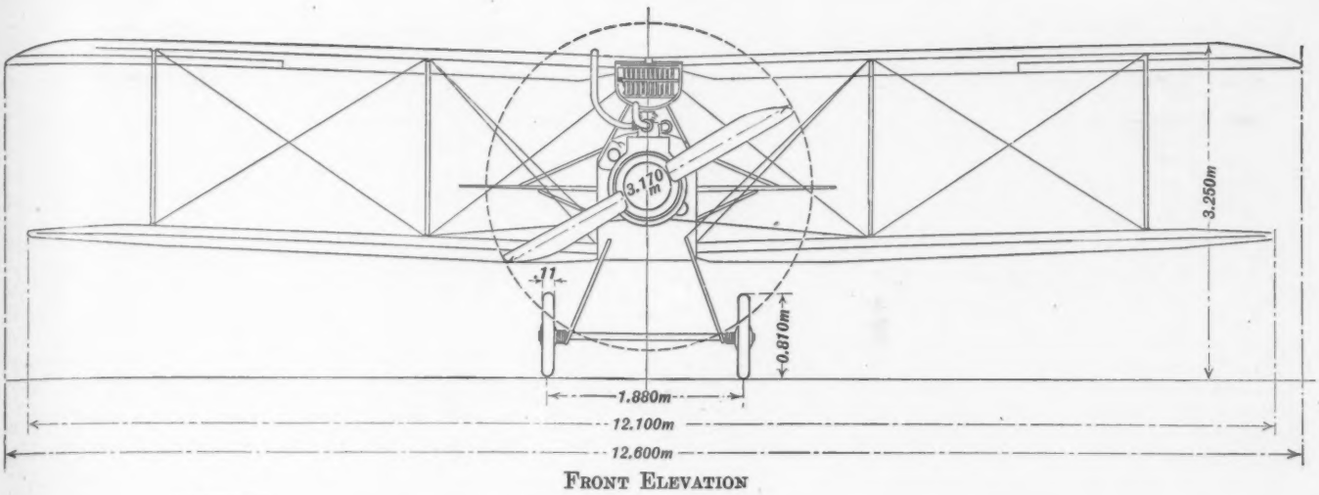
The total surface area is 33.5 sq. m., of which the upper wing carries 20 sq. m., and the lower wing, 13.5 sq. m.

The Tail Planes.—These consist, as on most German machines, of horizontal and vertical fins, elevator, and rudder. The horizontal fin, which is not adjustable, has a much smaller chord than is found on preceding types. In plan, the leading edge is of approximate semi-circular shape. The fin surfaces are supported on either side by a strut which is fixed at its other end to the lower body longeron. Two more struts serve as a brace for the vertical fin. The struts supporting the horizontal fin are ovalized steel tubes, which are provided on their lower face with sharp spikes; these apparently serve the purpose of preventing the handling crew from getting a hold of the tail struts, and, by wheeling the machine around, bending them.

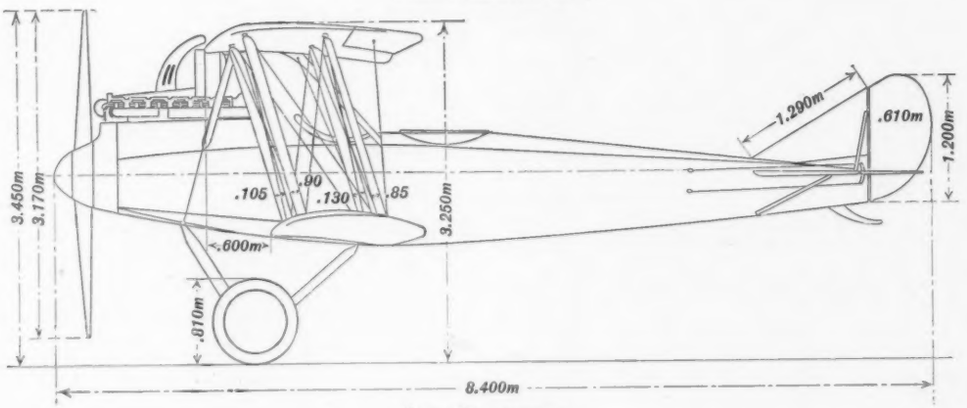
The elevator consists of two panels which are cut out to afford play to the rudder, and are slightly balanced by a protruding, triangular surface. The span is 3.70 m., and the chord, 0.61 m.

The vertical fin is of triangular shape. The rudder is of the non-balanced type, and is 1.20 m. high, and 0.61 m. wide. The structure of all the tail planes is built up of steel tubing.

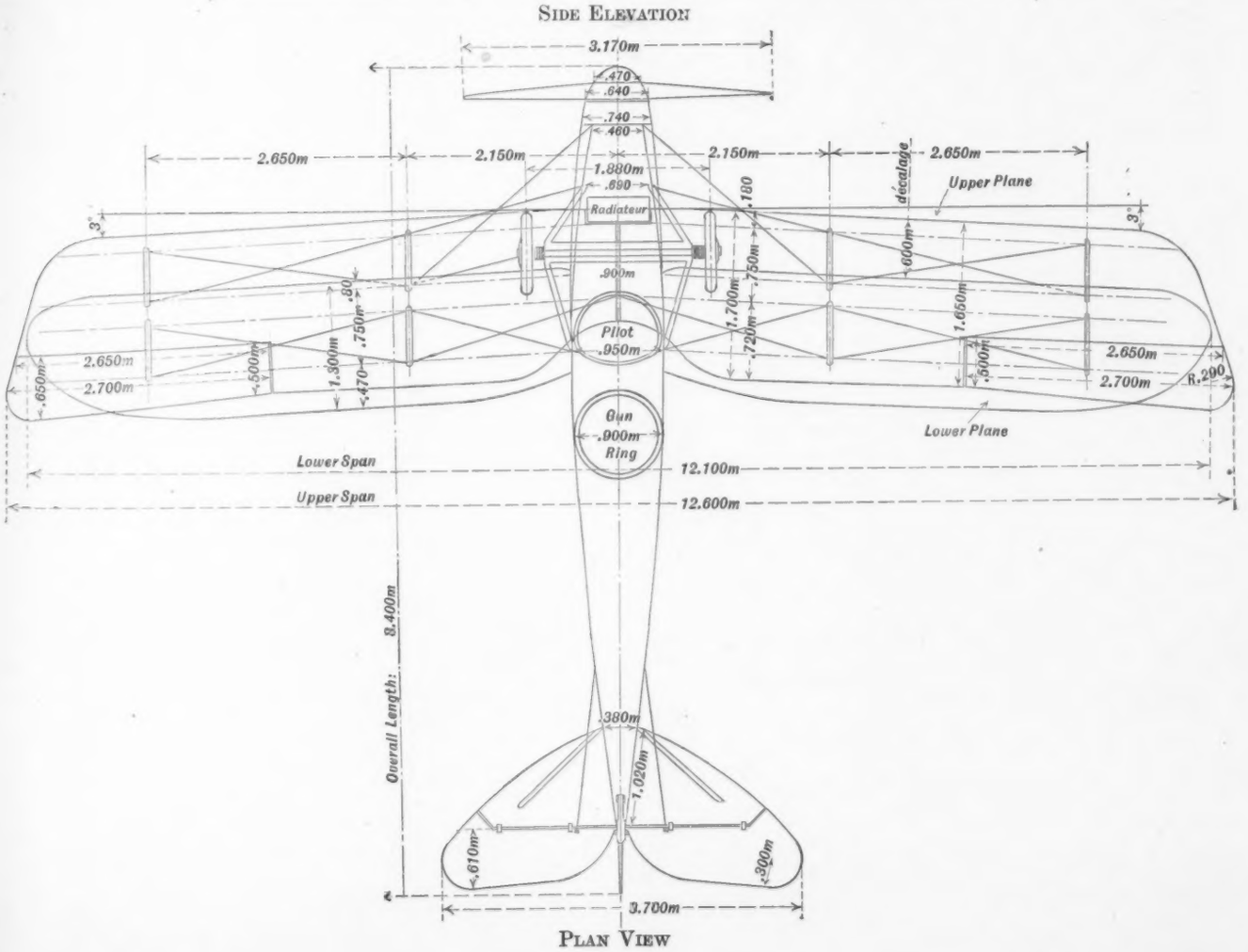
* Translated from *l'Aérophile*.



FRONT ELEVATION



SIDE ELEVATION



PLAN VIEW

The control cables are entirely carried within the body; to prevent jamming, the cables are partly led through small wooden tubes.

The Body.—The body is of rectangular cross-section, and is built up, in the current way, of four longerons and a number of cross-pieces braced by wire stays. The forward and after portions of the body are covered with veneer plates, while the central portion is fabric-covered. The maximum width, situated near the pilot cockpit, is 0.95 m. The four longerons taper toward the rear end into a vertical knife edge.

The Power Plant.—The power plant of the Rumpler C. IV consists of either a 260 h.p. Mercédès engine, or a 250 h.p. Maybach of the type currently employed on Zeppelin airships. Both engines are of the vertical, water-cooled 6-cylinder type. Where a Mercédès is fitted, the engine is slightly inclined to the right to enable the induction pipes to clear the cabane struts; with the Maybach this arrangement is not necessary, because this engine is less cumbrous.

The engine is fed from two fuel tanks. The main tank, holding about 220 litres, is mounted beneath the pilot's seat; the second, service tank holds about 70 litres and is placed between the pilot's seat and the after seat. Enough fuel is carried in the two tanks for a continuous flight of four hours' duration. When a Maybach is fitted, two service tanks are carried on either side of the body. With both engines the top of the cylinders protrudes beyond the cowling; the latter encloses a Spandau machine gun which is operated through synchronization by the engine.

The exhaust gases are led from the six cylinders to a common chimney which is curved backward, and is divided half way up into three branches, which seem to answer the purpose of obtaining a certain amount of silencing.

The radiator is placed, as in previous models, amidwings, on the forward cabane struts. Its cross-section is semi-circular. An arrangement similar to a Venetian blind is provided in front of the radiator to permit adjustment of the cooling surface.

Behind the engine there is the pilot cockpit, behind which is the cockpit of the gunner. The latter cockpit is provided with a gun ring of 0.090 m. diameter which mounts a Parabellum machine rifle. The pilot cockpit contains a bomb rack of the self-feeding type, such as is usually found on German machines. This rack holds four bombs. An opening is provided in the floor for taking photographs; a radio set is also installed in this machine.

The Undercarriage.—This is of the usual V-type, with a rubber sprung axle. Contrary to frequent German practice, no brake is fitted to the undercarriage.

A drift wire runs from the front end of the body, on either side, to the lower base of the inner front interplane strut. Another drift wire runs from the upper base of the same struts to the base of the forward undercarriage struts.

The particular machine on which the above description is based displayed careful camouflage: the lower face of the wings and of the body were painted a light blue, while the sides and top of the body as well as the upper face of the wings were painted alternately green and brown.

Curtiss is Granted Flying Boat Patent

The United States Patent Office granted on Feb. 19, 1918, the claims made in an application filed on Dec. 11, 1914, by Glenn H. Curtiss, the well known airplane constructor of Hammondsport, N. Y., in behalf of a patent covering the construction of stepped and V-bottomed flying boat hulls. The patent, No. 1,256,878, is specified by the patentee as follows:

My invention relates to hydroplane boats of the type commonly used in connection with hydro-aeroplanes of the flying boat type. It has for its objects the enabling of the craft to rise quickly from the water with maximum load aboard and having risen from the water to enable operation in the air with a minimum of head resistance due to the body of the boat. To these ends the main floatation body of the boat is given a longitudinal section of approximately streamline form, and a transverse section increasing in size from the head of the boat to a maximum approximately one-third length astern, and thereafter gradually decreasing in cross section until the tail of the boat is reached. This cross section is approximately the shape of an ellipse with one or both ends or sides cut off to form the bottom of the boat, or the top thereof, as the case may be. Further I decrease the minor axis of the ellipse more rapidly than the major axis as the cross section is decreased in the immediate vicinity of the tail of the boat, so that the section becomes substantially a straight line terminating in the vertical rudder post. Previous to this, the separate axes are independently varied in the rearward progression of adjacent cross sections, to obtain the streamlines with which the boat is characterized, and to bring out to the fullest extent the features of efficiency above enumerated. The bottom of the boat is stepped and the front portion thereof constitutes the active hydroplaning surfaces, while the rear portion thereof underlying the tail proper makes a salient angle therewith. Preferably the hydroplaning bottom is V-shaped. On the sides of the boat are formed excrescent structures the bottoms of which are in continuation of the hydroplaning bottom of the boat, and the longitudinal section of which is of streamline form. Preferably these excrescent structures are watertight, and are of an approximately triangular section.

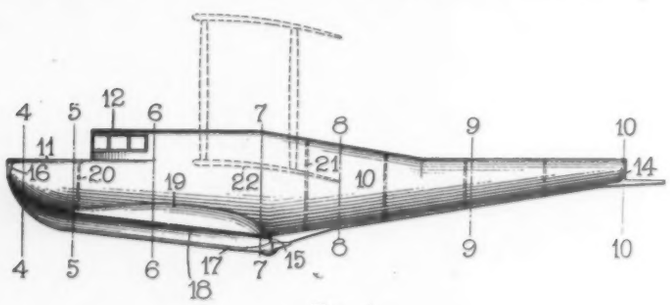


FIG. 1

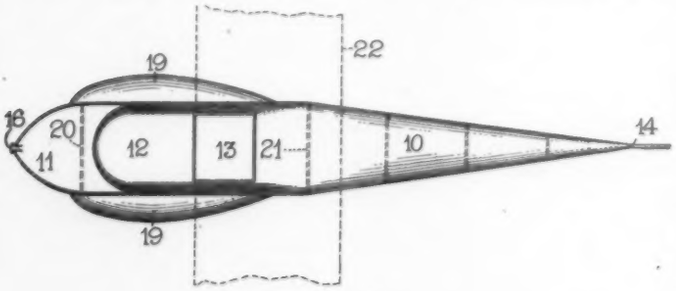


FIG. 2

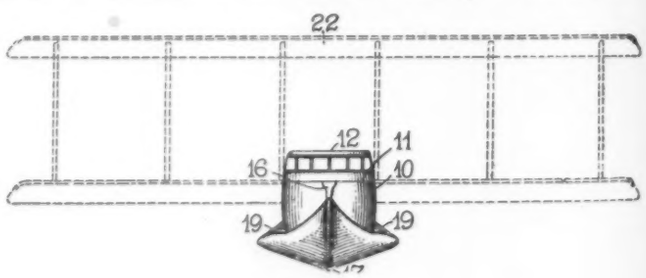
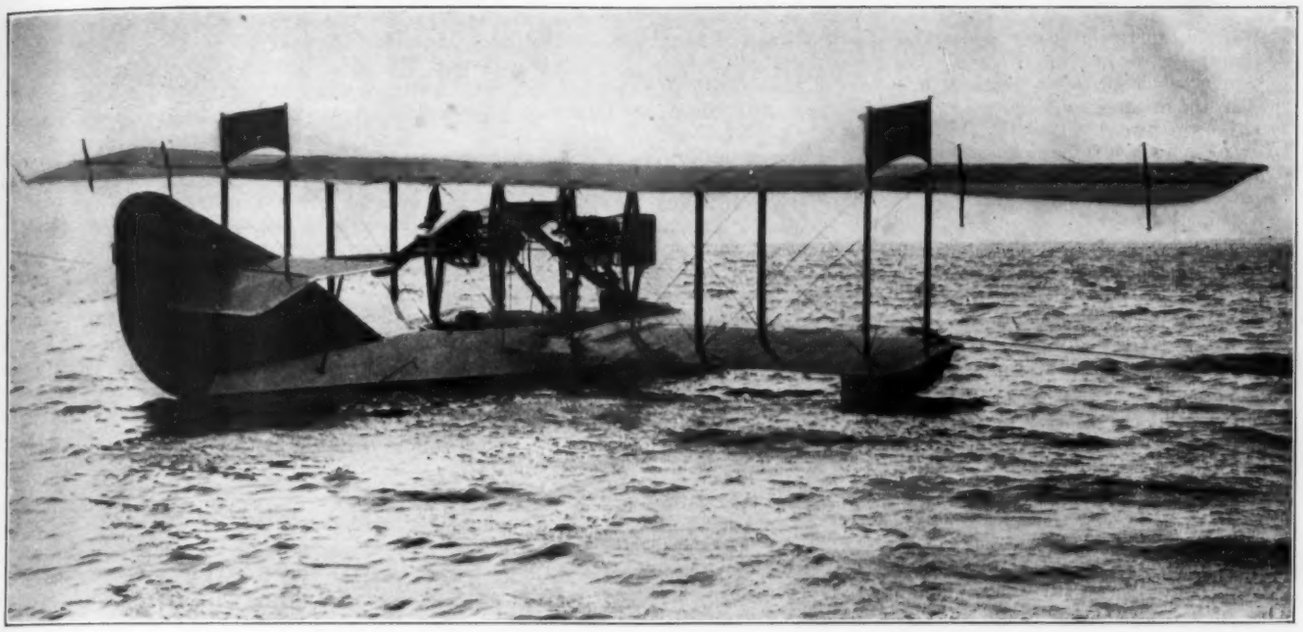


FIG. 3

In the accompanying drawings, I show one embodiment of my invention but wish it understood that as usual in the case of an invention of this character, my invention is capable of many other embodiments without departing in any wise from its generic spirit.

Of the drawings Figure 1 is a side elevation of the boat of my invention,

Fig. 2 is a plan thereof,



LARGE TWIN-ENGINED CURTISS FLYING BOAT
(C) *Underwood and Underwood*

Fig. 3 is a front elevation thereof showing aerial supporting surfaces attached and,

Figs. 4 to 10 inclusive are transverse sections on lines 4 to 10 of Fig. 1.

10 designates the flotation body of the boat. As clearly indicated in the side elevation and plan of Figs. 1 and 2 this body has a longitudinal section approximately streamline in form. There are a few slight irregularities in its surface, but these are insufficient to detract from the behavior of the boat in air as a streamline body. The principal variation is at the head or prow of the boat, where the top is cut straight back on the line 11 to form a front deck, and give unobstructed vision from the cabin 12. To complete the elevational streamline the cabin roof line would naturally be downwardly curved to round off into a substantially elliptical juncture with the nose. This forward elevational streamline, however, is interrupted by the provision of the fore deck 11 which extends horizontally and rearwardly to an intersection with the cabin, a cockpit being provided at the intersection of this deck with the cabin and a conning top having windows set therein being furnished to inclose this cockpit and to round off the interrupted lines of the cabin forwardly. The side and top walls of the cabin merge into the streamline of the body aft as

FIG. 4

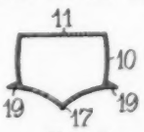


FIG. 5

indicated in Fig. 1. Entrance to the cabin is by a hatch door 13 in the top and preferably located beneath the upper aerial supporting surface whereby it is shielded from the weather.

The transverse section of the body of the boat is in the form of an ellipse cut away in some cases at opposite ends of an axis and in other cases at one end only. The section at the front of the boat as clearly shown in Figs. 4 to 7 is in the form of an ellipse cut away at each end of an axis, while the section at the tail of the boat as shown in Figs. 8 to 10 is in the form of an ellipse cut away at the lower end of one axis only. In the form shown this axis is the major axis, all of the major axes lying in the longitudinal vertical plane of the body. The cross section increases gradually to a maximum approximately one-third way astern, and thereafter decreases gradually. Both axes decrease proportionately for a part of the rearward distance traversed, then the major axis is shortened at the more rapid rate and finally the decrease of the minor axis of the elliptical section is made more rapidly than that of the major axis. These three successive stages clearly appear from inspection and comparison of Figs. 7—8, Figs. 8—9 and Figs. 9—10 respectively, the elliptical section eventually becoming a straight line in the rudder post 14. In other words the transverse section may be described as varyingly elliptical, the size of the ellipse (rearwardly from the prow) passing through successive stages in which (*a*) the major axis increases rearwardly more rapidly than the minor axis (*b*) both axes decreasing rearwardly, and (*c*) the minor axis decreases at a more rapid rate than the major axis, the said sectional ellipses terminating in a straight line at the rudder post.

The bottom of the boat is stepped as indicated at 15 (Fig. 1).

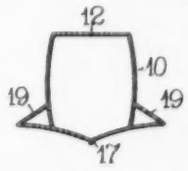


FIG. 6

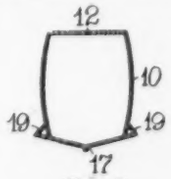


FIG. 7

The front portion thereof is of V section the angularity of which increases gradually from the stem 16 to the step 15 as indicated clearly in Figs. 4 to 7. Also it will be observed there is an abruptly increasing and then a gradually decreasing concavity of the opposite sides of the V-bottom merging into the substantially flat salient surfaces at the step 15. It will be observed however, that this concavity is not great in any case, and further that the downward and rearward inclination of the bottom at the keel 17 is substantially the same as that at the chimes 18, excepting at the upwardly inclined prow of the boat which portion of course has no hydroplaning function.

Projecting laterally from the sides of the flotation body 10 at or near the chime lines 18 are elongated excrescent structures 19. These structures have an approximately streamline form as clearly appears from Figs. 1 and 2. Transversely

FIG. 8

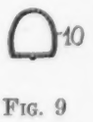


FIG. 9

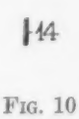


FIG. 10

they are of approximately triangular and varying cross section, one side of the said section being in continuation of the transverse section of the bottom of the boat (see Figs. 6 and 7), whereby their under surfaces constitute continuations of the main hydroplaning surfaces, another side conjoining the sides of the main body 10, and the third side extending downwardly and laterally therefrom. Considering the conjoint sides of the hull and fin excrescences as identical, as is usually the preferable construction, it will be observed that the fins

in cross section then become of an acute V-shape, one side of the V lying in the plane of the bottom and the other side intersecting therewith from the hull. These excrescent structures 19 are made watertight independently of the main body 10 and in the embodiment shown are each hermetically sealed. The two structures 19 and the front portion of the main body 10 make a total of three longitudinally extending watertight compartments. The front portion of the main body 10 is further transversely subdivided into watertight compartments as indicated by the dotted line bulkhead 20. The tail portion of the boat is also divided into watertight compartments by transversely extending bulkheads 21.

Aerial supporting surfaces 22 extend laterally from the body 10 as indicated. In the preferred form of my invention, there are provided a multiple number of these surfaces in superposed relation constituting the cell of a biplane or triplane as the case may be.

The fins 18, it will be observed, extend considerably beyond the center of the wings and therefore the hydroplaning area and lift is augmented in the neighborhood of the center of gravity and center of pressure as it should be. This location of the fins 18, although most effective after having gained the surface of the water, is of little importance in gaining this end. More important is it that the fins should be located in the vicinity of the resultant center of hydroplane lift so that the hydroplane lift will be increased at the point where it is most needed to be increased and at a point providing for quick rise from a submerged position at rest to a hydroplaning position upon the surface of the water at speed. The great advantage in so locating the fins is that the enormous thrust value occasioned by the elevated location of the motor or motors (not shown) is offset and the boat prevented from nosing under when coming to a hydroplaning position and when hydroplaning—especially when traveling at comparatively slow speed. In explanation, it is to be noted that three working forces are in evidence, to wit: gravity, thrust and hydroplane lift. Unless the hydroplane lift is sufficient to counteract the force of thrust, then the boat will have a tendency to plane with its nose low in the water. Were the fin excrescences omitted, the size of the fore body of the hull would have to be materially increased so that the hydroplaning area might be proportionately enlarged. This is objectionable because of the added weight and increased resistance during flight. The resultant center of hydroplane lift is shown by calculation to lie approximately one-third back of the forward end of the hydroplaning surface.

With this understanding of the structural embodiment of my invention, it will be clear that I have attained the objects thereof. The extended and very large hydroplaning surfaces provided by the bottoms of the excrescent structure 19 in conjunction with the main body 10 are of sufficient size to enable the body to come rapidly to its hydroplaning position and to rise from that position into the air with maximum load. In a recent trial, over a ton of useful load was lifted from the water in a run upon the surface not exceeding five hundred feet. The flying boat took to the air with great ease. As the head of the boat is pointed upwardly for the craft to take to the air, the tail, which until then is clear or substantially clear of the water is carried downwardly into contact therewith, the boat being as it were rocked about the step 15 as a pivot. This assists in enabling the boat to rise easily from the surface of the water by reason of the increased flotation and additional planing surface provided at the critical point in the operation. When the craft is in the air, the longitudinal streamline formation of the excrescences 18 prevents them from materially increasing the head resistance of the boat. Under actual flying conditions it was found that they produced no noticeable retarding effect. Of course the longitudinal streamline section of the body as a whole is productive of the same excellent results obtained in prior flying boats of my invention.

While on the surface of the water, or in the air for that matter, the operator has an excellent footing on the flat deck 11 and its form and location are especially adapted for the mounting and operation of machine guns for military purposes. The operator further has at all times unobstructed vision ahead directly over the flat deck 11, which forwardly mutilates the generating boat line of the cabin which would normally round off into the nose of the body.

The sealing of the excrescent structures 18 independently of the main body 10 gives to them the additional and very important function of watertight compartments. They are located at a point where these compartments are very much needed, directly opposite the cabin 12. It is of course not practicable to seal the cabin section. The flotation of this section of the boat is thereby materially raised and is assuredly of sufficient value under all conditions of service.

The Claims

1. An aeroplane body comprising a main flotation body, the bottom of which is shaped to form hydroplane surfaces, and forwardly located marginal excrescent structures on the sides of said main flotation body, the bottoms of which are coextensive with and in continuation of the hydroplaning surfaces of said bottom.

2. A hydroplane boat comprising a main flotation body, the bottom of which is shaped to form hydroplaning surfaces, and marginal excrescent structures on the sides of said flotation body, extending longitudinally substantially the full length of said hydroplaning surfaces and having their bottoms in continuation of said hydroplane surfaces.

3. A hydroplane boat for hydroaeroplanes comprising a main flotation body, the bottom of which is shaped to form hydroplaning surfaces, and forwardly located excrescent flotation structures of triangular cross section on the sides of said main flotation body opposite the resultant center of aeroplane lift, one side of said section being in continuation of the transverse section of the bottom of the boat, another side parallel to the side of the main body, and the third side extending laterally and downwardly from a point on the side of the boat intermediate the chime and the gunwale.

4. A hydroplane boat body having an interior watertight space for occupancy by the flying crew or other useful load together with watertight fin excrescences arranged to flank said space in the vicinity of the bottom of the boat, the excrescences conjointly functioning as planing surfaces and as lateral watertight compartments protecting said space.

5. A hydroplane boat body having an interior watertight space for occupancy by the flying crew or other useful load together with watertight compartments respectively ahead of, aft of, and at each side of said space, the side compartments being in the form of fin excrescences arranged to extend out laterally from the boat body proper to augment the hydroplaning area thereof.

6. A flying boat adapted to travel upon the surface of the water, rise therefrom and travel through the air, comprising a hydroplaning bottom surface laterally extended beyond the plane of the gunwales of the boat body proper by fin excrescences arranged at opposite sides of said body principally ahead of the center of gravity of the craft, the corresponding surfaces of said excrescences making a dihedral angle with the vertex thereof in the vertical plane of the keel line of said boat.

7. In a hull for flying boats, a V-shaped hydroplaning bottom and acutely V-shaped planing fins, each fin having one side formed in the plane of one of the V-sides of the bottom.

8. In a hull for flying boats, a V-shaped hydroplaning bottom, integral continuations of said bottom forming surfaces projecting beyond the hull and second surfaces projecting from the sides of the hull for intersection with the first said surfaces.

9. A flying boat including a main flotation body having a hydroplaning bottom, and fin excrescences arranged to augment said bottom laterally in the vicinity of the resultant center of hydroplane lift as determined through hydroplaning action on the surface of the water and preparatory to flight.

10. In a hull for flying boats, a V-shaped hydroplaning bottom and auxiliary planing fins formed as lateral extensions of said bottom, said fins being enlarged rearwardly from the bow of the hull in directions providing longitudinal and transverse streamlines.

11. In a flying boat, a hull rounding off rearwardly from its bow to provide a hydroplaning bottom and rounding off oppositely to provide a cabin situated over said bottom, and a fore deck for the hull intersecting the generating hull lines for the cabin.

12. A hull for flying boats enlarging rearwardly along rounded, upper and lower longitudinal hull lines, a hydroplaning bottom for the hull merging into the lower hull lines, and a deck intersecting the upper hull lines for provision of a cabin over said bottom.

13. In a flying boat, a hull, a cabin having streamlines

merging integrally into the hull in one direction and a conning top rounding off the streamlines of the cabin in the other direction.

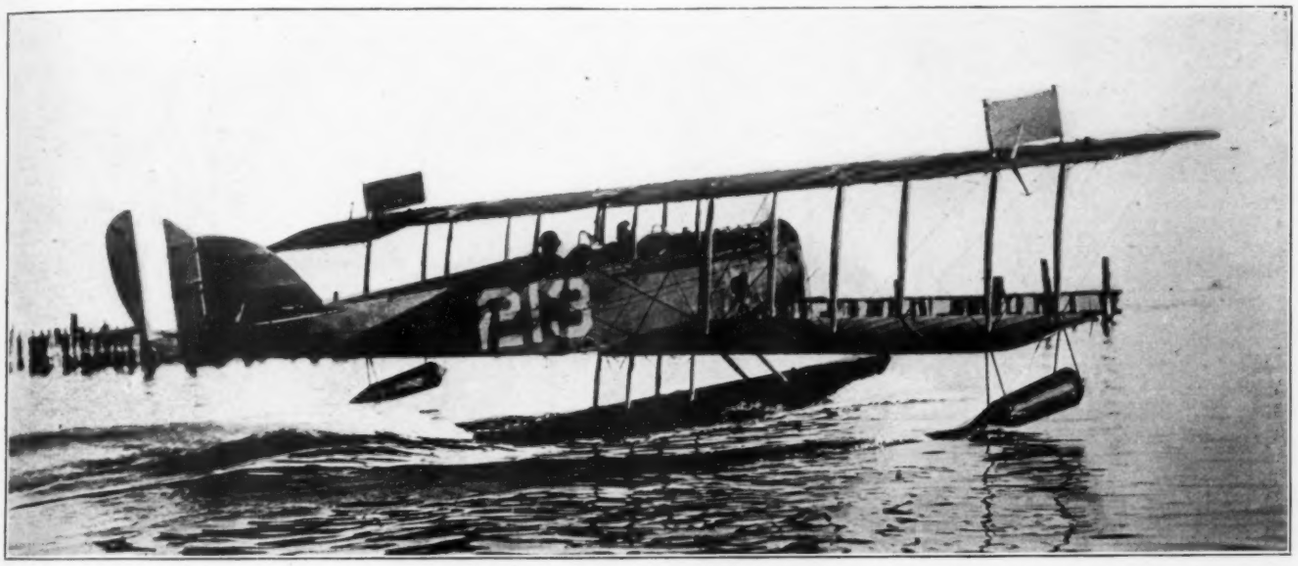
14. A hull for flying boats having its elevational aspect determined by lines rounding off rearwardly both upwardly and downwardly from the nose of the hull, and a deck intersecting the said upper boat line and cutting down the hull to provide a cabin.

15. In a hydroplane hull, an overhanging bow having an elevational aspect determined by lines rounding off rearwardly and downwardly, a bottom V-shaped in cross section, the angled portions of the bottom having their inception at the bow and considerably above the water line, each portion being decreasingly concaved from the nose rearwardly and the angle between the portions rearwardly approaching a maximum obtuseness, and a step terminating said bottom.

22. In a hydroaeroplane boat body, a bottom longitudinally convexed, and auxiliary planing surfaces formed as lateral extensions of said bottom in the vicinity of the resultant center of hydroplane lift, said center lying considerably in advance of the point of maximum convexity, and sufficiently distant therefrom to provide for its movement rearwardly to a point in the vicinity of said point of maximum convexity upon fore and aft oscillation of the boat.

23. In a hydroaeroplane boat body, a bottom longitudinally convexed, aeroplane wings extending intermediately across said body, the point of maximum convexity underlying said wings, auxiliary planing surfaces formed as lateral extensions of said bottom, said surfaces commencing in advance of the resultant center of hydroplane lift and terminating rearwardly in the vicinity of said point of maximum convexity.

24. In a ying boat, a main flotation body, a hydroplaning



CURTISS SEAPLANE OF THE CENTER-FLOAT TYPE
(C) *Committee on Public Information*

16. In a hydroplane hull, a fore-body, a tail, a planing step dividing the bottom of the fore-body from the tail bottom, an upper surface for the tail enlarging forwardly in a reverse curve over said step and a cabin roof provided over the fore-body in advance of said step and merging into said enlarging tail surface.

17. In a hydroplane hull, a fore-body, a tail, a planing step dividing the bottom of the fore-body from the tail bottom, an upper surface for the tail enlarging forwardly in a reverse curve over said step to form a cabin roof for the fore-body and a deck intersecting said fore-body at a distance below said roof and destroying a normal merging of the roof-line into the nose of the hull.

18. In a hydroplane hull, a fore-body, a tail, a cabin provided for said fore-body and having a roof merging rearwardly into said tail and forwardly into the nose of the hull, a deck intersecting the cabin and a cockpit provided at the intersection of said cabin and deck.

19. A flying boat including a flotation body having an underneath hydroplaning surface of a size in cross section designed to extend out on either side beyond the boat body proper approximately opposite the center of hydroplane lift, the bottom surfaces of the laterally extended portions making a dihedral angle with the vertex of the angle in the vertical plane of the keel line of the boat.

20. A flying boat including a main flotation body having an underneath hydroplaning surface of substantially V-form in transverse section, fin excrescences arranged to augment the hydroplaning surface laterally in the vicinity of the resultant center of hydroplane lift, the bottom surfaces of the fins continuing uninterruptedly the hydroplaning bottom of the boat body proper.

21. A flying boat including a main flotation body, a hydroplaning under surface, and lateral extensions of a construction designed to conform longitudinally to said hydroplaning under surface and to extend substantially the full length thereof.

under surface, fin excrescences coextensive with the hydroplaning surface, each fin extending forwardly beyond a line in the vertical plane of the resultant center of hydroplane lift a greater distance than to the rear thereof.

25. A flying boat including a forward hydroplaning bottom designed to extend from end to end uninterruptedly and at an angle laterally beyond the sides of the boat body proper to materially increase the hydroplaning surface and enable the boat to come rapidly to its hydroplaning position upon the surface of the water and to rise from that position into the air.

26. In a hydroplane boat, a bottom longitudinally convexed, and auxiliary planing surfaces formed as lateral extensions of said bottom to extend substantially the full length of that portion of said bottom ahead of a point determining the maximum convexity thereof.

27. In a hydroaeroplane flotation body, a longitudinally convexed bottom in which that portion of said bottom in advance of the point of maximum convexity is of hydroplaning form, fin excrescences arranged to augment said bottom laterally in the vicinity of the resultant center of hydroplane lift, aeroplane wings, the center of pressure on said wings being disposed in the approximate transverse vertical plane of said point of maximum convexity, and said point determining the rearward terminus of said fins and the rearmost point to which the center of hydroplane lift may be shifted as the body in its entirety is oscillated fore and aft.

Pershing Recommends Six-Gun Plane

More powerful armament has recently been proposed for fighting airplanes. In response to an inquiry, Gen. Pershing has recommended at least two heavy and two light machine guns, adding:

"We should anticipate the use of three Vickers synchronized guns and three Lewis unsynchronized guns on every airplane."

The Medical Aspects of Airplane Accidents*

By H. Graeme Anderson, M.B., Ch.B., F.R.C.S.

Temporary Surgeon R.N. (Attached Royal Naval Air Service)

In the early days of flying there were necessarily many accidents, owing first to structural weaknesses in the airplanes, and secondly to the fact that the pioneer pilots had to experiment and were mostly unacquainted with many of the factors governing aerial navigation. When man began to teach man, and as improvements in the construction of airplanes increased, so accidents diminished in number proportionately; but, on the other hand, many more took up flying and the total of accidents was increased. The pre-war methods of teaching were slow and sure, and first solo flights were made in stages, and after prolonged tuition, thus tending almost to obviate accidents altogether. As the war advanced and the importance of aviation was recognized more pilots were needed, and the methods of teaching had to be accelerated; after a few hours' dual-control instruction pupils were sent off to do their first solo flights. Naturally many more accidents occurred, and as nowadays tuition is on faster and more powerful airplanes, so have the total number of accidents increased. Every accident teaches something new, and all should be investigated thoroughly, so that a preventable cause or error can be eliminated in the future. In this connection the reports of the Public Safety and Accidents Investigation Committee of the Royal Aero Club are very instructive and should be studied.

The total number of accidents due to school work and experimental flying is greatly augmented by the number due to war flying, either the result of aerial duels or anti-aircraft fire from the ground.

An attempt has been made to classify accidents at one station covering a period of six months, and these are referred to as the "V" series. In a general review of accidents, I have also drawn from fifteen months' experience whilst at another school, and these are referred to as the "E" series.

In the "V" series during six months 4,000 hours' flying were done, consisting of 9,000 flights, and during that time 58 airplanes were wrecked or crashed. The suggested definition of a crash is an airplane so damaged in a flying accident that it has to be deleted or sent into the workshops for repair or rebuilding. This is in contradistinction to the effects of a bad landing or get-off where the ensuing damage is small and can be repaired by the flight mechanics. Fifty-eight crashes in 9,000 flights represents one crash in every 155 flights. In these 58 crashes 16 airmen were injured, which is equivalent to 28 injuries in every 100 crashes, or one pupil injured in every 560 flights.

From these figures one can see that school flying is fairly safe and compares favorably with other high velocity forms of transit.

From this list of 58 crashes the following table is compiled to show the frequency of crashes and injuries on early solo flights:

No. of Solo.	Number of crashes. With injury to Pilot.	Without injury to Pilot.	Total.
1st	1	8	9
2nd	5	4	9
3rd	1	3	4
4th	0	3	3
5th	1	2	3
6th	0	1	1
7th	3	5	8
8th	0	1	1
9th	0	2	2
10th	0	1	1
12th	1	1	2
After 10 hours	2	12	14
Dual control	1	0	1
Total	15	43	58

The table shows a greater frequency of crashes on the first and second solos, then a diminution from the third to the sixth inclusive, and a rapid rise again on the seventh. The inference suggested is that by the time the pupil arrives at his seventh solo he becomes over-confident and a little careless.

Causes of Airplane Accidents

The causes of airplane accidents are: (1) defect in the airplane; (2) error in judgment in flying; (3) "loss of head"; (4) brain fatigue or lethargy; (5) fear; (6) physical illness; (7) unavoidable causes.

In an analysis of the 58 crashes in the "V" series, the following table shows the frequency of these causes:

Cause.	Number of crashes. With injury to Pilot.	Without injury to Pilot.	Total.
1 Airplane defect:			
(*a*) Breakage	1	0	1
(*b*) Engine failure	..	..	..
2 Error of judgment	4	38	42
3 Loss of head	6	1	7
4 Brain fatigue	3	1	4
5 Fear	..	..	..
6 Physical illness	..	..	..
7 Unavoidable	1	3	4
Total	15	43	58

1. Defect in Airplane

This implies mechanical failure of some part of the airplane, and can be subdivided into (*a*) breakage in the air and (*b*) engine failure.

(*a*) *Breakage.*—In the early days of aviation breakage or giving way in the air of some vital part of the airplane—for example, the folding back of a wing—was fairly common, and was due to faulty design or weakness in construction. Happily, to a great extent this has been corrected, and at the present time very few accidents are due to this cause. In three years' experience with the R.N.A.S. I have not seen a machine actually break in the air. In one case in the "E" series an elevator control wire jammed and caused the airplane to nose-dive, with fatal results to both occupants.

(*b*) *Engine Failure.*—Engine failure *per se* may be a direct cause of an airplane accident—for example, if the engine fails just as the airplane is leaving the ground and there is unsuitable landing ground the pilot may not have sufficient height or air space to avoid obstacles in front. Or in landing the pilot may find in his glide downwards that he has undershot or overshot the mark and his engine will not "pick up" or respond to carry him on further to suitable landing ground.

On the other hand, engine failure may not be a direct cause, but may be a strong contributory or indirect cause of an accident. In all cases if the engine fails in the air a forced landing is compulsory, but given a fair height—2,000 feet or more—the pilot can usually select a good field for landing and arrange his descent accordingly. Of course, on approaching the field to land it may be found not quite so good as imagined from a greater height—for example, sloping ground, long grass, etc.—and thus the pilot may make an error of judgment on actually landing. This quite often occurs with a pupil, but rarely with an experienced aviator, who knows exactly how to "pancake" his machine. But even in the case of experienced aviators engine failure just after leaving the ground is a strong contributory cause to the the real cause of an accident—namely, an error of judgment in flying. Authorities cite as one of the commonest examples of airplane accidents engine failure just after leaving the ground, when the pilot tries to turn back to his original starting-place, loses height in the turning, and, in trying to prolong his glide, loses flying speed—stalls—and the airplane falls to the ground out of control. In the "V" series engine failure was the direct cause in one case and was a contributory cause in two cases.

2. Error of Judgment

Error of judgment in flying is the commonest cause of airplane accidents. This error may occur in getting off the ground, in the air, or on landing.

Of the 58 crashes in the "V" series this cause accounted for 42—4 in getting off the ground and 38 on landing. Of the many examples of error of judgment in flying perhaps the commonest is when, on landing, the pupil misjudges his distance from the ground and either "flattens out" too soon and "pancakes," with a possible crash depending on the height, or else "flattens out" too late and strikes the ground at a varying angle, usually overturning and wrecking the machine.

* Abstract of an article published in the *Journal of the Royal Naval Medical Service.*

Other examples in the air are putting on too much "bank" with insufficient "rudder" or *vice versa;* climbing on a turn; and, as in engine failure, prolonging a "glide" so that the machine loses flying speed.

It is difficult to estimate and account for these errors of judgment. In some cases it may be due to under-instruction. In other cases, even after prolonged instruction, the pupil may still misjudge distances, and on examination one occasionally finds that his standard of vision is below normal; but, on the other hand, he may be found physically fit, with normal vision and good balancing power. In the latter cases it may be a question of delayed reaction time, especially the visual reaction time on which the aviator is so much dependent. Normally this reaction time takes 19/100ths or 20/100ths of a second. It may be delayed by fatigue, drugs, and excesses; but, on the other hand, in some individuals who are otherwise physically fit it is found to be much slower than in others. Hence, in the selection of candidates for aviation the visual and other reaction times must be up to the normal standard. By the French medical authorities on aviation candidates are rejected if the reaction times are found to be of the delayed type.

3. *Loss of Head*

Loss of head occurs fairly frequently in a greater or less degree and accounts for a fair proportion of accidents—seven in the present "V" series. The pupil in his new occupation of flying for the first time has all his mental faculties on the alert, at extreme high tension; the sense of danger, although not asserting itself, is ever-present, but subconscious. Under the sudden strain of an emergency his power to reason and act synchronously may momentarily lapse, resulting in what is known as loss of head. In a critical position the pupil has to think, decide, and act quickly, but with loss of head the mental balance becomes upset; there is no mental inertia, but the wrong decision is taken and acted on. In flying, seconds and parts of a second count enormously, and may mean all the difference between safety and danger. After actual loss of head there is seldom time to correct the error made. As examples of loss of head in the air the pupil in an emergency may move the throttle the wrong way, may keep his engine full on when he should throttle down, or may switch off his engine at a moment when he requires all the flying speed possible. Loss of head is very much allied to the two following causes.

4. *Brain Fatigue*

In contradistinction to loss of head, the pupil in brain fatigue reaches the stage where he has neither the power to reason, decide, nor act. A state of mental inertia supervenes. This is due to repeated stimuli received by his brain in rapid succession in his flight—he feels alone; a succession of errors occurs in the air; he feels he cannot manage to control the airplane; fear does not seize him, but the enormity of the whole thing appals him; he feels helpless, and a state of brain fatigue occurs in which he, in a stupor, awaits events and takes little part in the airplane's control. After a careful study of 100 of the first solo flight confessions of pupils, and of many pupils who have had crashes, I am convinced that brain fatigue is a cause of a fair proportion of accidents. Four occurred in the 58 of the "V" series. As a rule in brain fatigue the pupil fails to flatten out, and the airplane strikes the ground at its gliding angle and becomes wrecked. On questioning a suspected case of brain fatigue immediately after his flight one finds usually that there is very little recollection of what happened during the flight; memory seems to become partially stunned. It is difficult to make a diagnosis of those liable to brain fatigue. As a rule, if it occurs, the pupil, even should he escape injury, soon gives up flying. He is not of the temperament suitable for flying. As a preventive the pupil's first few solo flights should always be of short duration.

5. *Fear*

Fear, at least in a degree sufficient to disturb one's flying, is rarely experienced in the air on the first few solo flights, whatever the sensations may be before going up or in the intervals between flying. The mind is far too much occupied and concentrated on details of flying, watching the various instruments that record air speed, height, levels, and engine's revolutions, and in judging position and direction in the air relative to the ground. From an analysis of the confessions of the first solo flights of 100 pupils and of my own it is curious to note that very few experience fear in the air, at least not in a degree sufficient to disturb flying. Many confess to a sense of danger lurking somewhere at the back of the head, but say that it rarely if ever asserts itself. In the "V" series no crash occurred through fear.

6. *Physical Illness*

In the series of crashes under consideration none was attributable to physical illness. At an air station medical inspection of the pilots and pupils at regular intervals reveals any organic disease that might lead to loss of consciousness in the air.

Flying on an empty stomach may cause faintness in the air. In schools flying commences at dawn, and all pupils are provided with a good meal of cocoa, tea, and bread-and-butter. Similarly on long flights pilots are provided with tabloid forms of nourishment. The effects of cold and fatigue may produce faintness or stupor in the air. There are many instances on record of pilots fainting in the air either through being wounded or from high altitude effects. Some have been known to recover consciousness before reaching the ground and to make successful landings. Two pupils in the "E" series suffered from attacks of malaria in the air and both were made to discontinue flying. Another pupil in "E" series, although slow to learn, was making fair progress, but one day he was noticed to descend rather steeply; he made no attempt to flatten out, the airplane struck the ground at its gliding angle, and the pilot was thrown out, clear of the machine, a distance of 66 feet, and escaped with only a slight sprain of one ankle. A few days later in the ward-room this pupil was seized with a series of typical epileptic fits. On inquiry a history of epilepsy for the previous five years was elicited. This was undoubtedly a case of an epileptic fit taking place in the air.

7. *Unavoidable Causes*

From time to time unavoidable accidents arise. Every precaution is taken at a flying school to prevent collisions in the air or on the ground. Set signals are made with regard to the direction of circuits and landing areas for different flights. The terrain in certain areas may be unsuitable and conceal obstacles; again, in some airplanes the view of the sky or ground in certain positions may be limited. These conditions may cause unavoidable accidents. In the "V" series four accidents were unavoidable. Two were due to bad terrain with obstacles concealed in the grass; in the case of the other two a collision took place in the air.

Type of Accidents

The term "type of accident" has been suggested to describe the part of the flight in which the cause of the accident was initiated. It is possible to make an arbitrary division of a flight into three parts: First, the getting off the ground into the air up to 50 or 100 feet; second, in the air, with the various turns, figures of eight, climb, spirals, etc.; and, third, the landing, which includes the descent from the time the throttle is closed to the time the airplane is brought to a standstill on the ground.

The following table gives an analysis of the types in the "V" series:

	Number of crashes.		
Type of Accident.	With injury to Pilot.	Without injury to Pilot.	Total.
1 In getting off	4	6	10
2 In the air	2	0	2
3 In landing	9	37	46
Total	15	43	58

Some of the errors which the pupil may make in getting off are raising the airplane's tail too high, slewing to one side, or getting off with one wing down. In the air a pupil may lose flying speed or stall, or may sideslip or spin. The commonest type of accident is in landing—the pupil's *bête noire.* He may either flatten out too soon, lose flying speed some feet from the ground, and the machine "pancake," or else he may be too late in attempting to flatten out, and the airplane strikes the ground at an angle, turns over, and is wrecked.

Scheme for First Aid at an Air Station

The sick-bay or dressing station should be in full view of the aerodrome, with a look-out man supplied with field glasses always on duty during flying hours. Should the dressing station not be situated on the aerodrome, the former should be connected by telephone to the look-out man, whose position commands a good view of the flying area. Immediately a crash or false landing occurs, the look-out man telephones to

the sick-bay notifying the steward the exact site of its occurrence. A map of the aerodrome, numbered in quadrants, can be conveniently arranged in the sick-bay. The look-out man then leaves his post and proceeds to the scene of accident, taking the wheeled hand stretcher, on which is carried a first aid dressing bag and emergency tool kit case. The latter consists of an oblong box containing the following:

1. Two crowbars.
2. Two strong wire cutters.
3. Saw.
4. A long stout knife.
5. A hammer.
6. Strong cloth cutting scissors.
7. A fire extinguisher.

The above set of implements is very necessary, as in some crashes where the pilot is pinned under the wreckage it may be difficult to reach him. An injured aviator should never be dragged out of a crash unless in the case of fire, but rather the wrecked machine should be cut away from him. In many cases this prevents simple fractures from being converted into compound ones. The steward on being notified of an accident dispatches the ambulance, which stands always in readiness by the sick-bay, to the scene of the accident. The ambulance should be provided with twin wheels aft in order to facilitate movements on soft earth, etc. Two sick berth attendants go with the ambulance, and with them is a bag containing the following articles:

1. Morphine solution and two Wildey's hypodermic syringes.
2. A bottle of chloroform and face mask.
3. Brandy.
4. A bottle of sterilized water.
5. Six first aid field dressings and slings.
6. Picric acid dressings.
7. A tourniquet, cloth cutting scissors, and a knife.

These articles can easily be packed into a small bag 10 in. by 8 in. by 3 in. The surgeon on duty is on the aerodrome during flying hours, and proceeds to the scene of the accident by car or foot. If the accident is at a distance, a mile or more, it is better to go by airplane. I have now gone by air to over thirty forced landings and accidents at a distance, and am convinced of the utility of this method in arriving quickly and not otherwise tired and out of breath after a long run. In discovering the site of forced landings and accidents at a distance from the aerodrome much depends on the condition of the country around. Should this be flat country, these accidents are fairly easily discovered, but in some flying schools the surrounding land may be uneven, intersected with dykes and high-hedged roads. Thus it may be extremely difficult for the search party to find the wreck. Officers and flight mechanics sent to the scene of accident should be trained in first aid with special reference to airplane accidents. Flying pupils should not be allowed to come near or help, except in exceptional circumstances.

Often the crash is so severe that the wreckage has to be cut away from the injured aviator. In other cases the machine is upside down, with the pilot held head downward by his safety belt. The latter must be cut and the pilot slid gently out. The emergency tools are used to cut wires, remove wreckage, and lever away the heavy parts—for example, the engine—and thus easily to reach the injured person. The airplane seat cushion is taken from the machine and placed under the injured pilot's head, while his body rests on a flying coat spread out on the ground. A rapid examination is carried out to determine the injuries received. If the injured person is conscious and in much pain morphine should be injected and he should be conveyed quickly to the dressing station, where clothes can be cut away, injuries examined, and treated accordingly. If unconscious, some cutting away of clothing can be done on the field, injuries examined, and perhaps a dislocation reduced or a fracture accurately diagnosed during the unconscious period. In cases of fire, unless the pilot is thrown clear, the extinguishers must be used; but if there is any wind blowing they are of little use, as an airplane on fire is destroyed completely within a few minutes. The pilot's leather clothing for a time usually protects the body, but the face and lower limbs rarely escape. As the pain is so severe, and this applies to other injuries apart from those caused by fire, it is better to give chloroform on the field, and this is kept up on the way back to the dressing station. Morphine should also be given, but it takes some time to act.

Some Factors Relative to Airplane Accidents

The injuries sustained are akin to most high velocity accidents, but are usually more severe, as greater speed is used in aviation. They are composed of:

1. Injuries due to crushing, where some part of the pilot's body gets crushed between parts of the wrecked airplane. Crushing injuries are very severe in nature and mostly fatal in the pusher type of airplane (engine behind).
2. Injuries due to collision with the ground, as when the pilot is thrown out or hits the ground with his head in turning over in and with the airplane.
3. Injuries due to impact with different parts of the airplane, as when the head is violently jerked forward and strikes the edge of the nacelle on the airplane's impact with the ground. Flying débris, such as broken struts and wires, may cause local impact injuries.
4. Injuries from fire.
5. Drowning and immersion effects in seaplane work.
6. Suspension effects, as when the pilot is suspended head downward in an overturned airplane and is unable to loosen his safety belt. In many crashes the sudden impact of the pilot's body on the safety belt causes abdominal injury.

The injuries sustained vary a good deal, and depend on the type and power of the airplane and the cause and type of accident. An experience of three years attached to the Royal Naval Air Service impresses me more and more with the element of luck which befalls pilots in crashes. The present-day school airplane is much stronger in construction and more powerfully engined than in earlier days, thus providing for a greater margin of error on the pupil's part. The pusher type of school machine (for example, the Maurice-Farman) is considered very safe. It can be landed slowly, and has a powerful engine to cover errors. In a crash it has a strong under-carriage and a great deal of woodwork to absorb the shock before actual injury occurs to the pilot. On the other hand, in a nose-dive in this type of machine the engine, being behind, is likely to crush the pilot severely, and this usually proves fatal. In tractor machines the engine in front takes most of the shock in a crash, but the observer's seat just behind the engine usually gets telescoped or crumpled sideways. The pilot's seat, which is behind these, usually escapes crushing effects. If the pilot receives injury, this occurs either from his being thrown out or from his head being violently jerked forward and hitting the nacelle edge, windscreen, or instrument board. Should the safety belt hold, the sudden impact of the pilot's abdomen and lower part of chest against it may cause internal injuries. Nowadays most nacelle edges are padded, and safety belts are stronger and broader.

Safety Belts

With regard to the use of safety belts, endless discussion has taken place among aviators. My own opinion is that before leaving the ground all aviators should see that their safety belts are fastened and should be familiar with the method of their quick release. The belt should never be undone in the air. Thus the pilot, in the event of fainting, losing consciousness, or being wounded, or encountering gusty and bumpy weather or fog, has a safeguard to prevent him either being thrown out in the air or thrown forward on to his control lever (thus causing the airplane to nose dive), or having his feet jerked off the rudder bar (thus losing steering power). I think all are agreed on the above, but the difficult question arises whether to release the belt near the end of a glide before landing. This I would advise in the pusher type of airplane, but in the tractor machines it remains an open question.

Certainly if the airplane catches fire in a crash little hope can be entertained of the pilot if he be strapped in. Safety for him depends on his being thrown out clear of the machine. A narrow belt is to be condemned. The ideal safety belt should be broad and resilient, attached to the framework of the airplane and not to the pilot's seat, should be made to release easily and quickly, not at the center of the pilot's body but at the side where it is attached to the airplane. This release should be effected by means of a small hand lever. It is advisable for all pilots to carry a stout knife in the outside pocket of their flying coat in order to cut the belt should they be held in upside down after a crash.

Safety Helmets

These are of undoubted value in school work and should be worn by all pupils. They should fit properly and not be easily

dislodged whilst flying. The modern ones are much lighter and less high in the crown than the earlier ones used. In a crash they certainly prevent scalp wounds from broken struts and wires, and the side flaps protect the ears from injury. Over and over again I have seen pilots thrown out who owe their escape from more or less serious head wounds to their safety helmets.

On the other hand, in a turn-over, the added height of the crown may catch the ground and wrench the head either forward or backward, causing fracture dislocation of the neck, or severe strain and possible rupture of the muscles of neck and back.

As pointed out by Fleet Surgeon Wells, an ideal safety helmet would take its support from the shoulders.

Goggles

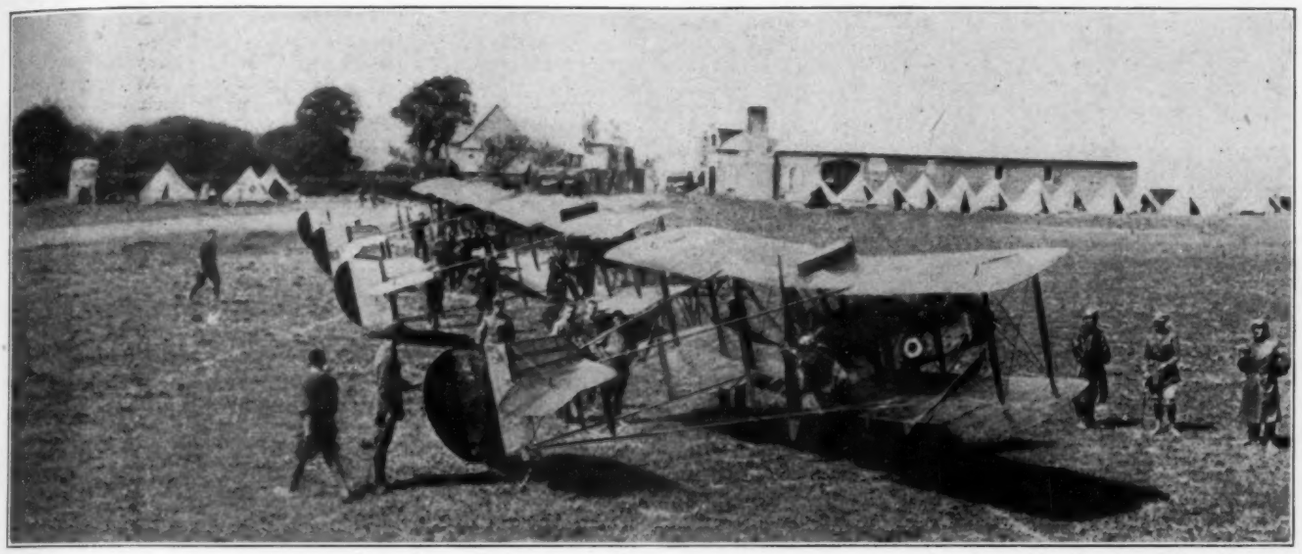
Most aviators wear goggles, but there are still some who prefer to fly without them. I know of one instructor who, after a year continuously instructing pupils and wearing no goggles, began to suffer from a form of conjunctivitis. I certainly think that goggles should always be worn. There is no doubt that flying without goggles is apt to set up a spasm in the eyes which in the long run is bound to do harm. Triplex or non-splintering material is now almost universally used instead of glass in the manufacture of aviation goggles. Thus rarely in a crash do we get any injury to the eyes. The nose-piece connecting the two lunettes should have no metal in its composition. I have seen some cases where wounds of the nose were caused by the metal connecting part of the lunettes.

Accidents Under Dual Control

Accidents under dual control are not common, as the instructor has usually time to correct in the air any of the pupil's errors in flying. One occurred in the "V" series, and was unavoidable owing to the character of the ground. In the "E" series three occurred. All dual control machines should be fitted with a mechanical device for throwing out of action quickly the pupil's control of the machine. I have seen three other crashes under dual control but without injury to either instructor or pupil.

Fatal Accidents

In two years of school work I have only seen three fatal accidents occur in roughly 200 crashes. Four deaths occurred, of which three were instantaneous and one after four days. All were due to multiple injuries.



A Flight of British Vickers Scouts Ready for Action

(C) *Underwood and Underwood* *British Official Photo*

Book Review

All the World's Aircraft, 1917. Founded by the late Fred T. Jane. Edited and compiled by C. G. Grey, Editor of *The Aeroplane*. Sampson Low, Marston and Co., Ltd., London. (21 s. net., 600 pp., fully illustrated.)

This well known standard reference book on aircraft has just appeared in its eighth year of issue under the able editorship of Charles G. Grey, the editor of *The Aeroplane*. The present issue contains, like the preceding ones, an immense amount of practical and technical information on the air services and the aircraft industry of all the nations. It should therefore prove of real value to the serious student of aeronautics as well as to the members of the Air Service and of the aircraft industry, the more so as the value of handily tabulated data contained therein are fully supplemented with illustrations.

The work is sub-divided into five parts. The first part contains an aeronautical dictionary, an international glossary of technical terms in English, Danish, Dutch, French, German, and Italian, and comprehensive tables of the official world's records (Speed, Distance, Duration, and Altitude) established by airplanes. As far as one is able to gather, only one real error may be found in the aeronautical dictionary, and this is the attribution of the meaning "airship" to the French term *aéronef*, which in reality means "aircraft," that is, any kind of aerial vehicle.

The second part contains tabulated data and illustrations of the world's airplanes and seaplanes, arranged in alphabetical order of nationality, with a preface on war flying, written by Captain W. E. DeB. Whittaker. Owing to military exigencies information relative to Allied machines is needs incomplete, but this is compensated for by a great wealth of data and illustrations of enemy airplanes.

The third part is devoted to a survey of the world's airships, with an introduction by W. L. Wade, and a special chapter on kite-balloons. Owing to the great secrecy which has enveloped, and is still shrouding, the airship constructions of both belligerents, this part is interesting more from the historical than from the topical point of view.

The fourth part treats of aero-engines and contains a preface by Geoffrey de Holden-Stone, dealing with present tendencies prevailing in the design of aero-engines. A goodly number of American engines are described in this place besides due reference to Allied and enemy products. One misses however a mention of a few well-known French airship engines, such as the Chenu, the Clément-Bayard, the Dansette-Gillet (Laviator), etc.

The fifth, and last part, is not the least interesting of all, for it contains seventy-six pages of illustrations depicting the most important airplanes which have been instrumental in the progress of aviation from 1902 to 1916.

Considering the serious difficulties a compilation of an aeronautical reference book, like All the World's Aircraft, must necessarily encounter in time of war, the work reviewed appears on the main as fully satisfactory.

International Aircraft Standards

(Continued from previous issues)

4P5—Specifications for Square and Round Bevel Washers

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

USE.—2. These washers are to be used on bolts (I. A. S. B. specification 4P3).

MATERIAL.—3. The washers shall be machined from cold-rolled or drawn steel (I. A. S. B. specification 3S20).

MANUFACTURE.—4. The washers may be cut by shearing if this can be done without distorting the surface. They shall be cyanide hardened. The washers shall be copper-plated in a cyanide bath and then nickel-plated; the coating shall not exceed 0.001 in. (0.0254 mm.) in thickness.

WORKMANSHIP AND FINISH.—5. Both sides must be flat and free from burrs.

PHYSICAL PROPERTIES AND TESTS.—6. Washers selected for the bend test shall be firmly clamped in a square-nose vise and bent through an angle of 30 degrees. They shall withstand this bending without cracking. One of every 250 washers shall be subjected to the bend test.

DIMENSIONS AND TOLERANCES.—7. The washers shall be of the form shown in figures 1 and 2 and shall conform to the dimensions within the tolerances given in following table. The values represent the finished dimensions after copper and nickel plating.

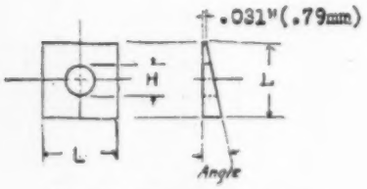


FIG. 1. SQUARE WASHER

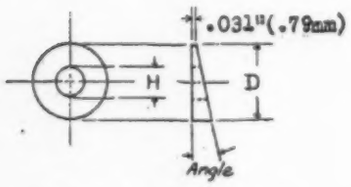


FIG. 2. ROUND WASHER

DIMENSIONS AND TOLERANCES FOR BEVEL WASHERS

[Values of angles are 6, 12, 24, or 36 degrees for all sizes.]

Bolt size.		H.		D.	L.	Bolt size.	H.	D.	L.
No.	*Inch.*	*No.*	*Inch.*	*Inch.*	*Inch.*	*Millimeters.*	*Millimeters.*	*Millimeters.*	*Millimeters.*
4	0.112	31	0.120	0.375	0.375	2.85	3.05	9.53	9.53
6	0.138	26	0.147	0.438	0.375	3.51	3.73	11.11	9.53
8	0.164	17	0.173	0.469	0.469	4.17	4.39	11.91	11.91
10	0.190	8	0.199	0.500	0.469	4.83	5.05	12.70	11.91
12	0.216	1	0.228	0.563	0.531	5.49	6.09	14.29	13.49
..	0.250	..	0.266	0.625	0.531	6.35	6.75	15.88	13.49
..	0.312	..	0.328	0.688	0.656	7.93	8.33	17.46	16.67
..	0.375	..	0.391	0.750	0.656	9.52	9.92	19.05	16.69
..	0.437	..	0.453	0.938	0.875	11.11	11.50	23.81	22.23
..	0.500	..	0.516	1.000	0.875	12.70	13.10	25.40	22.23

DELIVERY, PACKING, AND SHIPPING.—8. The washers shall be delivered in boxes of gross weight not exceeding 50 lb. (22.7 kg.). The lots of individual sizes shall be packed in strong manila envelopes or cartons.

3S38—Specifications for Valve Forgings

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings are made shall be chosen from the I. A. S. B. standard steels listed below. The composition chosen shall be stated by the manufacturer or contractor.

For exhaust valves, steel W60, W60*a*, or 51230 shall be used.

For inlet valves, steel W60*b*, X3340, or X3440 may be used and shall conform to the requirements of specification 3S8.

MANUFACTURE.—3. The forgings shall be annealed before machining or heat treating.

WORKMANSHIP AND FINISH. — 4. (*a*) The forgings must be uniform in quality, free from pipes, laps, cracks, twists, and seams, and must have a workmanlike finish.

(*b*) A forging may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected forgings shall be returned to the manufacturer at his expense. This clause shall not apply to forgings fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. The forgings shall be capable of developing the following physical properties when heat treated:

(*a*) Forgings from steels W60 or W60*a* shall show the following hardness:

Brinell hardness number	320 to 370
Shore scleroscope hardness number	55 to 65

Tensile Test.—(*b*)

	Forgings from steel—51230. Pounds per square inch.	Forgings from steel—51230. Kilograms per square millimeter.	Forgings from steel—W60*b*, X3340, or X3440. Pounds per square inch.	Forgings from steel—W60*b*, X3340, or X3440. Kilograms per square millimeter.
Minimum tensile strength	90,000	63.27	225,000	158.18
Minimum yield point	67,500	47.45	180,000	126.54
Minimum elongation in 2 inches (50.8 mm.)	18 per cent.		9 per cent.	
Minimum reduction of area	50 per cent.		30 per cent.	

Brinell Hardness Test.—(*c*) The Brinell hardness test shall be made after the

Chemical composition of steels

NICKEL-CHROMIUM STEELS

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
X3340	0.35-0.45	0.45-0.75	0.040	0.045	2.75-3.25	0.70-0.95
X3440	.35- .45	.30- .60	.040	.045	4.00-5.00	1.00-1.50

CHROMIUM STEEL

Number.	Carbon.	Manganese. maximum.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
51230	0.20-0.40	0.50	0.035	0.035	None.	11.50-14.00

TUNGSTEN STEELS

Number.	Carbon.	Manganese. maximum.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Tungsten.
W60	0.50-0.70	0.30	0.035	0.035	3.00-4.00	13.00-15.00
W60*a*	.50- .70	.30	.035	.035	3.00-4.00	16.00-18.00
W60*b*	.50- .70	.30	.035	.035	.50-1.00	1.50- 2.00

4E1—Specifications for Construction of Airplane Propellers

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability a part of these specifications.

MATERIALS. — 2. (*a*) *Wood.* — Woods used for the manufacture of propellers for motors of more than 150 hp., or more than 1,600 r.p.m., are to be black walnut, true mahogany, or quarter-sawed white oak.

For machines under 150 hp. and 1,600 r.p.m., will also be allowed the use of West African mahogany, cherry, and birch. In any case, the manufacturer is not allowed to use a different material from that speci-

fied in the design without permission of the purchaser.

Thickness of the boards shall be 0.75 to 1.0 in., finished.

(*b*) The laminations of the propellers being of irregular shape, imperfections are allowable on edges and parts of boards that will be cut away in the shaping of the propellers, but the stock that goes into the propeller must be straight grain, free from curls, burls, and spiral grain, without knots, checks, dry rot, shakes, dote, or other imperfections, in entire accordance with the I. A. S. B. specifications Nos. 2W3—8 for the lumber.

Sapwood is not permitted in the finished blade, and is not allowed to extend in boss more than 0.75 in. from the edge of the boss, and must in that case be sound.

(*c*) The physical properties of the wood shall be as specified in the I. A. S. B. specification No. 3W1.

(*d*) Stock shall be dried to a moisture content of 7 per cent by methods given in the I. A. S. B. specification No. 3W2.

(*e*) The glue used shall conform to I. A. S. B. specification No. 2W2.

(*f*) Materials used for the sheathing of propellers for seaplanes may be the following:

(1) Sheet copper in conformity to I. A. S. B. specification 3N8.

(2) Monel metal sheet in conformity to I. A. S. B. specification 3N21.

(3) Linen in conformity to I. A. S. B. specification 2F3.

(4) Cotton fabric in conformity to I. A. S. B. specification 2F4.

(*g*) The spar varnish used shall conform to I. A. S. B. specification 2V1; the filler, to I. A. S. B. specification 2V2. The priming varnish shall be made by dilution of spar varnish with about 2 parts of turpentine.

Manufacture.—3. (*a*) Each board shall be sawed and planed in accordance with blue prints. After planing they shall be glued promptly to avoid absorption of moisture, and great care must be taken to keep the wood under uniform conditions of temperature and humidity during all the operations.

(*b*) Boards shall be balanced before gluing, and heavy ends alternated so as to minimize the effect of variation in the density of the material.

(*c*) The boards shall be sawed for gluing in such a way that the grain follows the lamination of the propeller, avoiding any cross grain. At the same time, the boards shall be so arranged that the grain comes out on the edge, avoiding any flat grain.

(*d*) The practice of gluing edge pieces onto the boards in order to fill out at the boss is forbidden, unless special permission is given by the purchaser. In case such permission is given, the lamination on both sides of the boss widener must be of the full width of the boss; that is, no two laminations which have wideners glued to them shall be adjacent. Both the lamination and the boss widener shall be corrugated at the joint to increase the gluing surface. No splice or "dutchman" shall be permitted on the blade of the propeller. Defective joints shall not be filled with glue. The practice of gluing a thin strip of veneer to the blades will not be allowed.

(*e*) The glue room must be kept at a temperature of 90 deg. to 100 deg. F. (32 deg. to 38 deg. C.), and an average pressure in gluing of 150 lb. per sq. in. (0.11 kg./mm.^{2}) shall be maintained. Care shall be taken to insure an even pressure on all the parts of the glued surface for not less than 10 hr. or longer, at the option of the purchaser. The pressure in the gluing process must not be removed before the expiration of 8 hr. after it is completed. This period may be increased at the option of the purchaser.

(*f*) The propeller shall stand at least two days after gluing, nor shall it be finished in less than two weeks after roughing out.

(*g*) The surface of the propeller shall be smoothly sandpapered before the filler is applied, and the curvature shall be true and smooth throughout the length of the blade. Irregularities of contour are not permissible.

Tolerances.—4. (*a*) Propellers shall be inspected for pitch angle, alignment, blade form, and shape of section, as soon as they are finished by the manufacturer and shall come within the following tolerance limits:

	Portion of blades more than 50 per cent radius from axis.	Portion of blades less than 50 per cent radius from axis.
Alignment within	0.0625 inch	0.0625 inch.
Error in fit of templets	0.01 × width of blade	0.02 × width of blade.
Width of blade	0.075 × width of blade	0.01 × width of blade.
Thickness of section	0.0625 inch	0.125 inch.

For the inner half of the blade length the deviation from the specified pitch angle shall not exceed ±1.0 deg. at any station, and the difference between the pitch angles at corresponding stations on opposite blades must not differ by more than 1.0 deg. For the outer half of the blade length the average deviation shall not exceed ±0.3 deg, the maximum deviation shall not exceed ±0.5 deg., and the difference between corresponding opposite averages and maximum shall not exceed 0.3 deg. and 0.5 deg., respectively.

(*b*) The diameter shall conform to the drawings within plus or minus 0.125 in. The inspector may accept propellers when the diameter is 0.50 in. under specified dimensions, providing not more than 1 propeller in 10 is more than 0.125 in. under the specified diameter.

(*c*) Blades on the same propeller shall be alike within the limits given above. For example, the thickness of the blade may be 0.0625 in. greater or less than specified, but two blades on the same propeller shall not differ in thickness by more than 0.0625 in.

(*d*) Propellers shall be inspected for alignment at the time of shipment and shall track within 0.0625 in. If the propeller is not over 0,315 in. out of track, it is permissible to correct the alignment by scraping the wood in the boss.

Sheathing of Propeller with Fabric.—5. (*a*) Before application the fabric shall be scrubbed thoroughly with hot water and soda, and after rinsing allowed to soak in hot water for 4 hr. in order to remove all sizing from the cloth.

(*b*) The process shall be repeated until all the sizing is removed. The cloth shall be dried and applied to the blade in the glue room, with a standard temperature of 100 deg. F.

(*c*) The blades shall be coated evenly with glue, and the cloth applied and ironed smooth, preferably with an electric iron.

(*d*) Twenty-four hr. after gluing the fabric shall be given four coats of acetate dope, followed by two coats of varnish or enamel which conforms to I. A. S. B. specifications No. 2V1.

Sheathing of Propellers with Copper or Naval Brass.—6. (*a*) Metal sheathing shall be set in flush with the blade. Rivets of the same material as the sheathing shall be spaced over the area of the sheathing. They shall be applied in such a way as to fit tightly without splitting the wood and shall be applied alternately from the face and the back. The rivets shall then be headed and filed to form a smooth surface. No rivets shall be driven closer than 1 in. from the propeller edge, except at the edge of the metal or in very small blades.

(*b*) A row of rivets about 0.625 in. apart shall be spaced along the edge of the sheathing.

(*c*) The rivets shall not exceed 0.085 in. in diameter and shall show a breaking load of at least 130 lb. (58.9 kg.) at the riveted end and 180 lb. (81.5 kg.) at the head end. The working stress due to centrifugal force shall not exceed 4,266 lb. per sq. in. (3kg./mm.^{2}).

(*d*) Sheathing shall be formed to the exact shape of the blade before any rivets are placed.

(*e*) The rivets shall be applied in such a way that they do not follow the line of the grain.

(*f*) When the work is complete the tip shall fit snugly against the wood. Buckling or lifting of the metal shall be considered ground for rejection.

(*g* Sheathing shall be perforated at the extreme tip by four holes 0.0625 to 0.0938 in. in diameter, to allow the moisture to be removed.

Finishing of Propellers.—7. Propellers shall be finished by the application of 1 coat filler, 2 coats priming varnish, and 3 coats of spar varnish. Each coat should be allowed sufficient time to dry before the application of the next coat.

Balancing of Propellers.—8. (*a*) The propellers shall be tested for balance after the shaping, and after each subsequent operation which effects the balance. For this test the propeller shall be mounted so that it can turn on a horizontal axis, and the sensitiveness of the mounting must be such that it will move at the application of 1 gram (equals 0.036 oz.) at a distance of 2 ft. (61 cm.) from the axis.

(*b*) The balancing shall be done in a room free from air currents.

(*c*) The propeller when completed shall stand on the balancing machine in any position without persistent motion in any direction.

Testing of Propellers.—9. (*a*) One propeller of each new design shall be tested by running for at least 10 hr. at rated speed on the engines for which it was designed.

(*b*) A centrifugal test of at least 1 hr. duration shall be run at a speed of 10 per cent in excess of the rated speed. This test applies to one propeller of each new or of each unconventional design and to propellers made by inexperienced builders.

(*c*) The deflection of the tip in an axial direction shall not exceed 0.75 in. when the propeller is turning in free air at the rated speed unless greater deflection is an intended feature of the design. This requirement applies to propellers having a diameter of less than 10 ft. (3.05 m.).

(*d*) Such additional tests as may be desired shall be stipulated for propellers of untried materials or of radical design, or larger than 10 ft.

Hubbing of Propellers.—10. (*a*) The large boss hole shall be bored before roughing and shaping in order to insure perfect alignment.

(*b*) The fit of the hub in the large hole shall be neat and close, and the metal flange shall not show perceptible shake. The fit of the bolts in the wood shall be

as tight as possible without danger of splitting the wood.

MARKING OF PROPELLERS.—11. *a*) The propellers shall be stamped in such a position on the boss as to be legible after the placing of the metal flange, with the following information: (1) Pitch, (2) diameter, (3) safe revolutions per minute, (4) whether right or left hand, and (5) serial number.

(*b*) On the blade shall be the manufacturer's trade-mark or name.

3S37—Specifications for Alloy Steel Seamless Tubes

(200,000 Pounds per Square Inch Tensile Strength)

GENERAL.—1. The general specifications 1G1 shall form, according to their applicability, a part of these specifications.

USE.—2. These tubes are suitable for airplane axles and structural members.

MATERIAL.—3. The material for these tubes shall be chosen from the I. A. S. B. standard steels listed below.

MANUFACTURE.—4. (*a*) The tubes shall be cold drawn and shall be furnished heat treated.

Heat Treatment.—(*b*) The tubes shall be heat treated to meet the physical properties specified. The quenching shall be done in oil. Tubes which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

(*c*) Any tube may be rejected at any time because of injurious defects or faults in the steel which are revealed by manufacturing operations, notwithstanding that it has previously passed inspection. Such rejected tubes shall be returned to the manufacturer at the latter's expense. This clause shall not apply to materials fabricated after expert.

WORKMANSHIP AND FINISH.—5. The tubes are to be smooth, of the section specified, and within the permissible tolerances as to wall thickness; of uniform diameter, free from scale, dirt, specks, longitudinal seams, laminations, grooves, and blisters, both internally and externally.

PHYSICAL PROPERTIES AND TESTS.—6. The tubes shall have the following physical properties:

Tensile Test.—(*a*)

	Pounds per square inch.	Kilograms per square millimeter.
Minimum tensile strength	200,000	140.6
Minimum elongation in 2 inches (50.8 mm.)	5 per cent	
Minimum elongation in 4 inches (101.6 mm.)	3 per cent	

Bend Test.—(*b*) Each axle tube shall be supported as shown in Fig. 1 and a load applied near the unsupported end which will develop a tensile stress of 185,000 lb. per sq. in. (130.0 kg. per sq. mm.) in the highest stressed fibers of the tube. (See formula below.) The load shall be applied in two equal increments. After the first the deflection of the tube at *B* shall be measured. The second increment shall then be applied for at least five seconds, and removed, and the deflection at *B* again measured. In case the deflection has increased more than 0.0625 in. (1.59 mm.) the tube shall be rejected.

SELECTION OF TEST SPECIMENS.—7. *Tensile Test Specimens.*—(*a*) One tube for the tensile test shall be selected at random from each lot of 100 tubes or less. In case the net sectional area of the tubing exceeds 0.85 sq. in. (548.4 sq. mm.), two standard test specimens may be machined from the tube before heat treatment. These specimens shall then be heat treated with the lot of tubes they represent, and must show the physical properties specified.

Bend Test Specimens.—(*b*) One end of each tube shall be subjected to the bend test, and one tube in ten shall be tested at both ends.

DIMENSIONS AND TOLERANCES.—8. (*a*) The following tolerances will be allowed on the outside diameter of tubes:

Tubes 1.5 in. (38.1 mm.) diameter and under	0.003 in. (0.08 mm.)
Tubes over 1.5 in. (38.1 mm.) diameter	0.005 in. (0.13 mm.)

(*b*) The variation in wall thickness of tubes may be 10 per cent of the dimensions specified.

(*c*) In no part of any tube shall the departure from straightness exceed 1 in 600.

(*d*) Tubes shall be straightened before heat treatment. After heat treatment the tubes must not be restraightened until the bend test has been applied.

DELIVERY, SHIPPING, AND PACKING.—9. The tubes shall be well oiled and delivered in boxes not exceeding 220 lb. (100 kg.) gross weight.

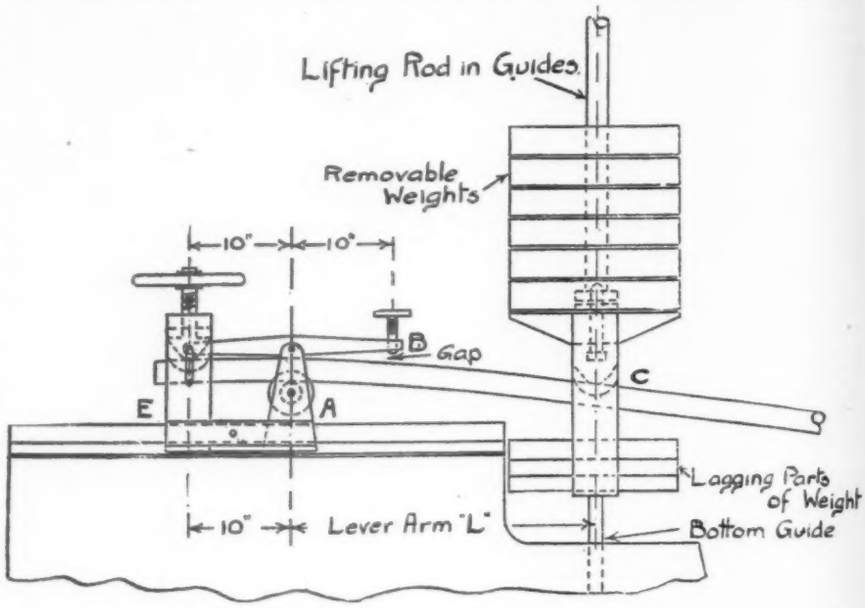


FIG. 1. DIAGRAM OF AXLE-TESTING APPARATUS

The extreme fiber stress shall be calculated from the folowing formula:

$$S = \frac{32\ WlD}{\pi(D^4 - d^4)},$$

Where S = extreme fiber stress.
W = the load.
l = distance from support to load.
D = outside diameter of tube.
d = inside diameter of tube.

Military Research Work

The Bureau of Standards at Washington, D. C., is engaged in some important military researches in behalf of the Army. This is in the nature of fundamental scientific investigations, and it embraces a wide range of problems.

Assistance has been rendered to manufacturers in the development of delicate aircraft instruments. Another problem that has been worked out is the location of gun batteries by sound, which is a triangulation proposition so promising that two experts have been sent to France to develop practically the discovery. Developments also have been made in instruments for testing materials and measuring temperature in connection with explosives. Then, too, success has attended experiments with optical glass, hitherto derived from foreign sources and now resulting in the development of the domestic industry.

Chemical compositions of standard alloy steels

NICKEL STEELS

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel
2330	0.25-0.35	0.50-0.80	0.040	0.045	3.25-3.75
2335	.30- .40	.50- .80	.040	.045	3.25-3.75

NICKEL-CHROMIUM STEELS

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Nickel.	Chromium.
3130	0.25-0.35	0.50-0.80	0.040	0.045	1.00-1.50	0.45-0.75
3135	.30- .40	.50- .80	.040	.045	1.00-1.50	.45- .75
3140	.35- .45	.50- .80	.040	.045	1.00-1.50	.45- .75
3230	.25 -.35	.30 -.60	.040	.045	1.50-2.00	.90-1.25
3240	.35 -.45	.30 -.60	.040	.045	1.50-2.00	.90-1.25

CHROMIUM-VANADIUM STEELS

Number.	Carbon.	Manganese.	Phosphorus, maximum.	Sulphur, maximum.	Chromium.	Vanadium minimum.
6130	0.25-0.35	0.50-0.80	0.040	0.045	0.80-1.10	0.15
6140	.35- .45	.50- .80	.040	.045	.80-1.10	.15

The bureau has been of great service in demonstrating that cypress and fir are proper substitutes for spruce in the manufacture of airplanes. In the same way oak, walnut and four or five other woods have been found as good as mahogany for airplane propellers. The airplane program was based upon covering airplane wings with linen from England, but the bureau has found that a cotton cloth designed by it is equally serviceable, and in most cases better than linen.

Digest of the Foreign Aeronautical Press

Aeronautics (London), January 30, 1918

A Japanese Aero-Engine Contest.—The Imperial Aviation Association of Japan sometime ago decided to hold a prize contest for aero-engines designed and built by Japanese. There were to be three prizes, of $10,000, $5000 and $2000 respectively for the engines attaining the highest average marks. The grading was done according to a system which included the number of hours the engine would run effectively, the weight per horse-power, the number of revolutions per minute, the net horse-power developed at the propeller shaft, the fuel and lubricating oil consumption, and the proportion of imported parts used on the engine. The committee which judged the engines was composed of professors from various technical schools, officers of the Army and Navy, and others. The contest was held on June 22 last, at Tokorozawa, the aviation field near Tokyo.

Twenty-two inventors had signified their intention to enter the contest, but at the time set only three entrants with four engines presented themselves. Two others, too late to enter into the official competition for the prizes, had their engines examined by the judges, but results were not recorded. The four engines officially examined were the following:

Name of inventor	Kishi	Shimadzu	Shimadzu	Asahina
Cycles	4	4	4	4
Cooling method	Air	Air	Air	Air
Number of cylinders	8	9	8	9
Bore	3.77 in.	4.13 in.	4.5 in.	4.5 in.
Stroke	4.72 in.	5.51 in.	4.5 in.	5 in.
Horse-power	70	80	90	100
Type	V	Rotary	V	Rotary
Revolutions per minute	1,400	1,200	1,800	1,100
Weight (pounds)	455.4	298	496.8	414

The engines were examined on the testing blocks. None of them except Mr. Shimadzu's rotary 9 cylinder engine achieved any large measure of success. Mr. Kishi's air-cooled V-type engine did not fulfil the expectations of the judges, owing to minor defects. This engine was able to run effectively for 1 hour and 19 minutes, but at no time developed more than 4.51 brake horsepower, although the indicated horsepower was 70. The failure of the engine seemed to be due to faulty adjustment rather than to poor construction.

Mr. Asahina's engine was of an original design and showed evidences of careful planning, but the selection of the materials and the proportion of the parts demonstrated that the whole engine was of amateurish construction. The engine ran for 1 minute and 27 seconds, and at one time developed more than 76.5 horsepower although it was rated at 100 horsepower. The stoppage was due to the breaking of one of the parts.

Mr. Shimadzu's 90 horsepower 8 cylinder V-type engine suffered a like fate. Up to the moment when it broke down, the engine ran only 2 minutes and 20 seconds, developing an average of 34.3 horsepower at 770 revolutions per minute.

The only really successful engine in the contest, and the one which won the first prize of $10,000, was Mr. Shimadzu's 9 cylinder rotary engine. This engine is said to be a close copy of the Gnome engine. It ran for 4 hours and 3 minutes, but as the revolutions and the horsepower developed during the last seven minutes fell considerably below the average, the time of effective running was 3 hours and 57 minutes. The slowing down during the last seven minutes and the final stopping of the engine were due to misfiring caused by carbon deposits in the cylinders.

The horsepower and the speed of the Shimadzu rotary engine were fairly steady throughout the time of effective running. The greatest horsepower developed was 74.6 and the lowest 58.6 while the revolutions per minute varied only from 1,140 to 1,020. The fuel consumption appears to have been very high, and the reports place it at 112 gallons for the 4 hours and 3 minutes of running, or at the rate of 43 gallons per horsepower-hour.

It is understood at present that Mr. Shimadzu intends to use the prize money to study aero-engines in America.

The Tomono engine was finished too late to enter the contest but was unofficially tested by the committee. No results of the test were published, however. The specifications of this engine are as follows:

Inventor, Tomono Naoji; cycles, 4; cooling, water; cylinders, 6; bore, 4½ inches; stroke, 4.375 inches; weight, 397 pounds; horsepower, 90; revolutions per minute, 1,200; type, vertical.

Flying (London), January 30, 1918

Protection of Engines Against Frost.—The substances which have been found most beneficial in reducing the temperature at which the freezing of the water circulating around the engine cylinders occurs are common salt, calcium chloride, sal-ammoniac, paraffin, glycerine and alcohol. Also mixture of glycerine and alcohol with water are often employed, and this appears to be the solution most favored for internal-combustion engines.

The freezing points obtainable with various proportions of water and alcohol become lower as the amount of the latter is increased, and the following data have been ascertained by careful observations:

Water.	Alcohol.	Freezing Point.
100 per cent.	0 per cent.	0 degree C.
95 "	5 "	—1 "
85 "	15 "	—9 degrees C.
80 "	20 "	—12 "
70 "	30 "	—18 "
65 "	35 "	—21 "

Glycerine added to the cooling water of internal-combustion engines produces an anti-freezing mixture which is not so susceptible to loss by evaporation as the foregoing. Any evaporation that occurs can be made good by simply adding clean soft water, as this is the only part of the mixture which boils away. In cooling systems on the thermosyphon principle this glycerine-and-water solution is found to be somewhat sluggish in circulating round the cylinder jackets and radiator; also where rubber connections are used the glycerine causes them to disintegrate after they have been in use a little time. When mixing the water and glycerine, care should be taken to pour the latter into the former, keeping it well stirred during the process. The following particulars have been ascertained as to the anti-freezing properties of glycerine-and-water mixtures of various densities:

Water.	Glycerine.	Freezing Point.
90 per cent.	10 per cent.	—1 degree C.
70 "	30 "	—8 degrees C.
60 "	40 "	—12 "
50 "	50 "	—16 "

The mixture of methylated spirit, glycerine, and water provides an anti-freezing mixture which appears to be the most suitable solution for internal-combustion engines, as the sluggishness of the glycerine mixture is overcome, and this liquid reacts on the evaporation of the methylated spirit, so that the loss of the latter is less than occurs when using the alcohol and water alone. There is a certain loss of the alcohol, and the amount that should be added to the mixture is rather difficult to decide, as this depends largely on the temperature that it attains, and should it be maintained very hot, more frequent additions will be necessary. As the glycerine does not evaporate, there is no need to make any addition of this to the solution; also this mixture does not have deleterious action on the rubber connections to the same extent as with the glycerine and water alone. The following table gives the temperatures that are obtained without solidifying when alcohol and glycerine in equal quantities are mixed with water in the proportions given:

Water.	Alcohol and Glycerine.	Freezing Point.
85 per cent.	15 per cent.	—6 degrees C.
75 "	25 "	—14 "
70 "	30 "	—17 "
60 "	40 "	—23 "

In frosty weather air-cooled engines have an advantage over those using water cooling for the cylinders, owing to the absence of any risk of damage to the cylinders or cylinder jackets. The cylinders or cylinder heads are arranged so that they readily give up their heat to the air, and the cooling may either be arranged by natural draught or by the circulation of air round the exterior of the cylinder walls by means of a fan. Usually the cylinders are thin castings, well ribbed on their exterior, and the ribs arranged so that they expose a considerable amount of surface to the air. Aluminum is rapidly coming into favor for air cooled cylinders of aero-engines, owing to the rapidity with which this metal gives up its heat to the cooling medium, and engines cooled on this system can be made of lighter weight than those using water for cooling their cylinders.

Plans for the Aerial Mail

Since the bids for airplanes for the proposed Washington-Philadelphia-New York aerial mail route were opened as published in the last issue of AVIATION AND AERONAUTICAL ENGINEERING several changes have been made in the program. They concern the details without particularly affecting the main features of the service and with the added considerations make for improvement rather than otherwise.

One of the most surprising of these changes is the announcement by the Post Office Department, that all the bids for the construction of the planes for this service have been rejected and that instead the planes will be supplied by the War Department.

The second change is that in place of five planes with one plane in reserve, for which bids were advertised, the number will be increased to six, with two in reserve. The eight planes will be "high power machines of the army type."

This arrangement admits of a third change, viz., the advancement of the date for the inauguration of the service. The date previously determined by the Post Office Department was about April 25, and it will be recalled that the three bidders asked for 63, 80 and 90 days respectively, for delivery, which in the two latter instances would have postponed the date to some time in May.

Through the cooperation of the War Department it has been made possible to advance the opening of the route at least ten days earlier than the original date. The date now set is not later than April 15.

The Department expects the trip between New York and Washington each way to be made in three hours on a fixed schedule. This will compare with 5 hours and 16 minutes at the average railroad time under nominal conditions.

Landing Places

The location of landing places at the New York terminal have not been definitely fixed. Governor's Island, which is about a fifteen minutes' trip from lower New York, was first under consideration as the place of landing. Now, the proposition is to land at either Van Cortlandt Park, New York City, or at Mineola, L. I., which is distant thirty-five minutes via the Long Island Railroad from the main uptown New York Post Office.

As between these two landings at New York, the officials prefer Van Cortlandt Park, unless it should develop after trials that the air currents there are such as to render it undesirable. If this proves to be the case the selection of Mineola would seem likely.

Other landing places are under consideration, among which are Flatbush Gardens, Sheepshead, Dyker Park and Gravesend, all of which are in Brooklyn. A fortnight ago, G. L. Commer, representing the Post Office Department; Lieut. Roy E. Ludick, from Hazelhurst Field, Mineola, N. Y.; Walter C. Burton, postmaster at Brooklyn, N. Y., and John Harman, Park Commissioner of Brooklyn, inspected several sites on Long Island as a landing place for the New York City terminus of the Washington-New York aerial mail route.

Pouches May Be Dropped in Net

Officials state that in case the landing site selected be too far distant from the New York post office that an arrangement will be made for dropping the mail bags into a net arranged in the hollow square around which the New York up-town post office is built, after which the planes will land at the selected landing field.

Extension of Route to Atlanta Suggested

The Post Office Department is understood to be considering the extension of the proposed New York-Washington mail route to Atlanta, Ga. This project has been proposed by Representative Thomas M. Bell of Georgia, a member of the House Committee on Post Offices and Post Roads.

It is suggested that airplanes between the New York and Atlanta terminals make stops at the following points: Philadelphia, Pa., Washington, D. C., Petersburg, Va., Charlotte, N. C., Spartansburg, S. C., and Greenville, S. C. Should this be done the length of the route would be increased by 648 miles, making the total distance between New York and Atlanta 873 miles, according to railroad figures, which are somewhat larger than airline distances.

Though, of course, civilian mail would be carried on the extension, the Washington-Atlanta route would, in large measure, be a soldiers' aerial mail service for at the stopping places mentioned are located several camps of the National Army and National Guard, viz.: Camps Lee and Gordon (N. A.) at Petersburg and Atlanta, respectively, and Camps Greene, Wadsworth and Sevier (N. G.) at, respectively, Charlotte, Spartansburg and Greenville. In fact, the connection of these camps with the capital and the facilitation of the delivery of officers' and soldiers' mail are understood to be among the chief objects of the proposition.

Arrangement Between the Departments

The arrangement between the two departments is twofold. The War Department is to furnish not only the airplanes, as stated, but the pilots and mechanics, and also a landing field and hangars at the Washington end of the route, while the Post Office Department will provide the landing fields and hangars at New York and Philadelphia. In addition, the Post Office Department will bear the expense of gasoline and upkeep of the machines and provide the motor trucks and clerical force necessary to the service.

A further provision is that the route will be conducted for one year as a part of the aeronautical training course of the War Department. In this way the aerial mail service will be carried on and the aviators will receive practice in long distance flights at one and the same time.

The Washington landing field and hangars will probably on the polo grounds in Potomac Park; but the Anacostia flats are tentatively under consideration in case that should be found more convenient. In Philadelphia the field and hangars will be at League Island.

Aerial Mail Stamp Proposed

In connection with the opening of the aerial mail route, it has been suggested that the Post Office Department issue a new stamp for this special service, which will perform a function similar to the special delivery stamp, for it will cause the letter to which it is affixed to be sent by the aerial mail. The present plan is to sell the stamp for 24 cents, which with the regular postage will make the cost for an ordinary letter 27 cents. It will be cheaper and quicker than a night letter by telegraph.

It is understood that no decision regarding the issuing of this stamp has as yet been made by the postal authorities, although the matter is said to be under consideration.

Important Airplane Station Planned for Cleveland

Successful culmination of plans of prominent Cleveland business men on the Airplane Committee of the Cleveland Chamber of Commerce will make that city the first to establish a commercial airplane station on an extensive scale.

The plan, as outlined to a representative of AVIATION AND AERONAUTICAL ENGINEERING, is to secure a 500-acre tract of land in the suburbs of the city upon which will be constructed hangars, repair shops and supply stores.

The proposed station is intended to serve military and postal as well as commercial and pleasure airplanes.

The plan contemplates making Cleveland a link in the Government air route for the delivery of planes from the Chicago-Detroit-Cleveland district to the flying fields.

As the Post Office Department proposes to make Cleveland one of the fourteen stations on two cross-country airplane mail routes, in addition to the Army route southwest to Texas, it is expected that the facilities of the Cleveland airplane field will also become available to postal airplanes.

The Airplane Committee of the Chamber of Commerce is headed by Alva Bradley, of the Bradley Real Estate Co. Glenn L. Martin, vice-president of the Glenn L. Martin Co., aircraft manufacturers, is chairman of the operations committee, the other members being T. P. Cragin, manager of the Statler Hotel, and A. E. Merkel, patent attorney. Selection of a site is in charge of W. A. Stinchcomb, county engineer, chairman; C. E. Thompson, president of the Pressed Steel Products Co.; C. P. Van Sweringer, real estate man. Alva Bradley is chairman of the Finance Committee. The other members are Munson Havens, secretary of the Chamber of Commerce, and W. L. Day, of the law firm of Squier, Saunders & Dempsey.

News of the Fortnight

$450,000,000 Asked for Army Aeronautics

The War Department on Monday asked Congress for an additional appropriation of $450,000,000 for the aviation program. Benedict Crowell, Assistant Secretary of War, in a letter to the Senate Military Affairs Committee, explained that $200,000,000 was needed to make good a deficiency in the $640,000,000 aviation fund provided by Congress last year, and that $250,000,000 more was necessary for new aircraft, supplies and equipment.

At the same time the Senate Appropriations Committee reported the Urgent Deficiency bill, carrying a total of appropriations and contract authorizations of $1,180,000,000, largely for the Army and the Navy. The bill as reported by the committee contains an increase of $73,000,000 over the appropriation voted by the House. The total amount appropriated outright is $761,000,000, while contracts authorized aggregate $419,000,000. The Army appropriation was increased $50,000,000 over the House figures, and the Navy received an increase of $17,000,000 from the committee.

"I am informed by the Chief Signal Officer that there exists a large deficiency in the appropriation referred to, even in view of the large amount covered by it, namely, '$640,000,000.'" Mr. Crowell wrote the Military Committee, "It was anticipated that the amount required by the Signal Corps would be very large, but even our anticipations have been exceeded and the $200,000,000 is needed to supply deficiencies that have already arisen.

"Besides the amount of the deficiency appropriation, namely, $200,000,000, there is incorporated in the bill an appropriation for $250,000,000. This is an appropriation for additional obligations for aircraft and other Signal Corps material and supplies."

One of the items recommended by the Senate Appropriation Committee is for purchase of land for warehouses for South Brooklyn at a cost of $705,000.

Liberty Engined Fighting Seaplane Is Ready

According to a statement issued on March 13 in Washington by the Associated Press the first American fighting seaplane, equipped with Liberty engines has successfully passed its acceptance tests. A number of these machines are now being delivered to the Naval Flying Corps and will eventually become the advance guard of a big fleet which is to be added to the forces engaged in submarine chasing in the war zone.

A second type of fighting airplane for the American army, known as the Bristol model, also has now reached the production stage and a considerable number will become available during the present month. Still another type, a two-seated machine, also is being manufactured.

Construction details of these airplanes have never been published. It is known, however, that the seaplanes are substantially similar to the British (Porte) flying boats and are equipped with two Liberty engines, which provide approximately 700 horse power. This is understood to be much in excess of the power used in similar British craft and their performance is expected to be better proportionately.

To Investigate Aeronautical Conditions

Appointment of a committee to make a survey of the Government's aeronautical program with relation to industrial conditions, was announced on March 12 by the War Department. It will comprise H. Snowden Marshall, former United States Attorney at New York; Edward Wells, of the Babcock & Wilcox Co., and a third member whose name will be announced later.

Harry B. Thayer Appointed to Aircraft Board

It was officially announced on Feb. 28 that the President has decided to appoint Harry B. Thayer of New York City as a member of the Aircraft Board. This nomination will complete the civilian membership, and consequently the full membership of the Board.

The nomination of Mr. Thayer was received by the Senate in executive session on March 1.

Lanzius Moves Office

The Lanzius Aircraft Corp. has moved its office from the Singer Building to 156 Broadway, New York.

Private Flying Is Licensed

The following proclamation by the President under date of Feb. 28 was made public on March 4:

Whereas, the United States of America is now at war, and the Army and Navy thereof are endangered in their operations and preparations by aircraft, I, Woodrow Wilson, President of the United States, by virtue of the authority vested in me by the Constitution as Commander-in-Chief of the Army and Navy of the United States and of the Militia of the several States when called into the actual service of the United States, do hereby, for the protection of such forces, issue the following proclamation:

I. A license must be obtained from the Joint Army and Navy Board on Aeronautic Cognizance by or in behalf of any person who contemplates flying in a balloon, airplane, seaplane, or other machine or device over or near any military or naval forces, camp, fort, battery, torpedo station, arsenal, munition factory, navy yard, naval station, coaling station, telephone or wireless or signal station, or any building or office connected with the National Defense, or any place or region within the jurisdiction or occupation of the United States which may be designated by the President as a zone of war-like operations or of war-like preparation.

II. The license will specify the person to whom it is issued, the machine to be used, the persons to operate the machine and all other persons to be carried therein, the mode of marking or otherwise identifying the machine, and other details intended to assure the military and naval forces of the peacefulness of the errand.

III. The license will also specify the territory and the time wherein it shall be available.

IV. In case any aircraft shall disregard this proclamation or the terms of the license, it shall be the right and duty of the military or naval forces to treat the aircraft as hostile and to fire upon it or otherwise destroy it, notwithstanding the resultant danger to human life.

V. For the present, the President designates as a zone of military operations and of military preparation the whole of the United States and its territorial waters and of the insular possessions and of the Panama Canal Zone.

VI. The provisions of this proclamation do not apply to aircraft operated by the Army or Navy of the United States.

VII. No private flying without a license will be permitted after the expiration of thirty days from the date of this proclamation.

Bill to Abolish Ratings and Pay

A bill now in the hands of the Senate Committee on Military Affairs, will, if passed, affect the Signal Corps and particularly the Aviation Section of the Regular Army, in its application to all aviators, their ratings and pay.

The bill was introduced for the War Department by Senator Duncan U. Fletcher of Florida, on March 4.

Salient features of the bill are:

The repeal of previous acts establishing the grades of junior military aviators, military aviators, junior military aeronauts, and military aeronauts.

The detail of aviation officers for a period of four years, and the redetail, if proficient in military aviation.

The eligibility of married as well as unmarried officers for flying.

The instruction of enlisted men in flying.

The age of officers which shall not bar their first detail; the age or rank which shall not bar their subsequent detail.

The creation of the grade of aviator for qualified civilians, at a base pay of $150 per month and with the allowances of a master signal electrician.

General Squier Commandeers C. P. I. Man

Arthur Woods has resigned as an associate of the chairman of the Committee on Public Information, Washington, D. C., to accept a commission as lieutenant colonel in the Air Division of the Signal Corps. An announcement of the committee states that the change is made in the interest of the national service, General Squier having convinced Mr. Creel of his large need for the executive ability of Mr. Woods. Col. Woods was Police Commissioner of New York City under Mayor Mitchel's administration.

Benjamin L. Williams Goes with Standard

Benjamin L. Williams, well known in the aeronautical industry as assistant secretary of the Manufacturers' Aircraft Association, Inc., has resigned to join the forces of the Standard Aircraft Corp. He has accepted the position of secretary to its president, Harry Bowers Mingle.

BENJAMIN L. WILLIAMS
(C) *Harris and Ewing*

Mr. Williams, who is not yet thirty-eight years old, was born at Newton, Sussex Co., N. J., on May 11, 1880. His start in the business world began in 1892, and his engineering career with the West Orange Water Co. at West Orange, N. J., in 1897, as clerk, being later advanced to assistant superintendent, and in 1904 as superintendent. He qualified for this position by studying the technical side of his work while engaged in the actual construction.

He remained in that position until 1907. In that year he was appointed assistant general superintendent of the Edison companies, Orange, N. J., later became their construction engineer, and was finally made plant engineer. In 1913, Mr. Williams devoted his energies to building management in New York City until the early part of 1917 when the Aircraft Manufacturers' Association was organized and he was made its secretary.

In these several positions Mr. Williams was an active element in the successful solution of the many problems encountered in the operating of public utility, industrial and isolated building plants the conditions of which were generally most unfavorable. He is ranked as an expert on industrial plant equipment, maintenance, construction, experimental work and process routing and has had an excellent experience on water supply and distribution, fire protection, sanitary work, building trades and property valuation. He has made numerous reports on manufacturing and engineering subjects and on matters relating to tax appeals on industrial plants and qualified as an expert on valuation of public utilities in the State of New Jersey.

Mr. Williams' activity in these various classes of engineering work has developed a fund of general business experience that was utilized to excellent advantage by the aircraft manufacturers, and the Standard Aircraft Corp. should find in him a valuable help in coordinating its extensive and expanding enterprise.

It is announced that as yet Mr. Williams' successor as assistant secretary of the Manufacturers Aircraft Association has not been selected.

Air Division Offices Move

Last week a number of the sections of the Air Division of the Signal Corps, Washington, D. C., was moved from their former locations in different parts of the city to the Arcade Building, 14th Street and Park Road, and it is understood to be the intention as far as possible to consolidate all the sections and divisions of the Air Division in this building.

Those already located in this building include the Aero Personnel, Information, Commissions, Statistics, Candidates, Recruiting, Orders, Examining Boards, Correspondence, Flying, Organization and Over Seas Transportation, Training Records, Executive, Engineering, Observation, Gunnery, Engineering, Radio, Schools, Balloon, Photographic, Bombing, Enlisted Mechanics, Motors, Promotion.

The offices of the English and French Aviation Missions are also located in this building.

Aeronautical Society Meets

The annual meeting of the Aeronautical Society of America, 29 West Thirty-ninth Street, New York, was held on March 5, 1918.

An interesting program was arranged by the Eagle Aviation School and members of the Royal Flying Corps spoke.

The following officers were elected: Frederick W. Barker, president; W. J. Hammer, first vice-president; Ernest D. Anderson, second vice-president; Charles W. Howell, third vice-president; Leon Cammen, fourth vice-president; Louis R. Adams, fifth vice-president; Carlos deZafra, treasurer; Louis A. Freedman, secretary, and Walter L. Post, counsel. The directors are Louis R. Adams, Frank O. Burridge, Howard E. Coffin, Wm. J. Hammer, Francis T. Sanford, Leon Cammen, Earle Atkinson, C. W. Wurster, Capt. Ernest L. Jones, Charles W. Howell, Lars G. Nilson, Gutzen Borglum, Capt. W. I. Chambers, Thomas R. Macmechen, Rudolph Hanau, Ernest D. Anderson, A. Leo Stevens, Matthew B. Sellers, C. B. Griswold, Frederick W. Barker, Charles R. Wittemann, Carlos deZafra, John J. Curran, Thomas A. Hill and Archibald Hart.

The Curtiss Election

At the annual meeting of the Curtiss Aeroplane and Motor Corporation, William A. Morgan was re-elected vice-president and general manager of the company's extensive organization. Mr. Morgan, who has spent the past two months in California and other Pacific Coast points, is now on his way East to resume his duties. The personnel of the Curtiss 1918 organization is as follows:

G. H. Curtiss, chairman of the board of directors; J. M. Willys, president; W. A. Morgan, vice-president and general manager; J. E. Kepperley, vice-president; C. M. Keys, vice-president; E. C. Morse, vice-president; W. W. Moss, vice-president and comptroller; B. A. Guy, secretary and assistant general manager; J. F. Prince, treasurer; H. M. Root, assistant comptroller; J. J. Donahue, assistant treasurer; J. F. Weber, assistant secretary.

Directors: G. H. Curtiss, C. H. Conners, Harry Evers, B. A. Guy, C. M. Keys, J. E. Kepperley, W. A. Morgan, W. W. Moss, F. H. Russell, J. Allan Smith, G. C. Taylor, J. M. Willys, Rodman Wanamaker, W. B. Stratton, J. A. D. McCurdy.

Four Aviation Departments Proposed

It is reported that there was held in Washington, D. C., on March 3, a meeting of officers of the Signal Corps, at which was considered the question of a division of the United States into four aviation departments, each in charge of an executive officer, with the rank of brigadier-general.

Hitherto the country has been divided into six subdivisions known as the Northeastern, Eastern, Southeastern, Central, Southern and Western Departments. It is now understood that these six departments are to be consolidated into four, as follows: Eastern Department, to include the Northeastern and Eastern Departments, with headquarters at Governor's Island; Southeastern Department, covering the same territory as before, with headquarters at Atlanta instead of at Charleston; Southern Department, embracing the same territory as under the old division, with headquarters at San Antonio; and Central Department, including the Central and Western Departments, with headquarters at Chicago.

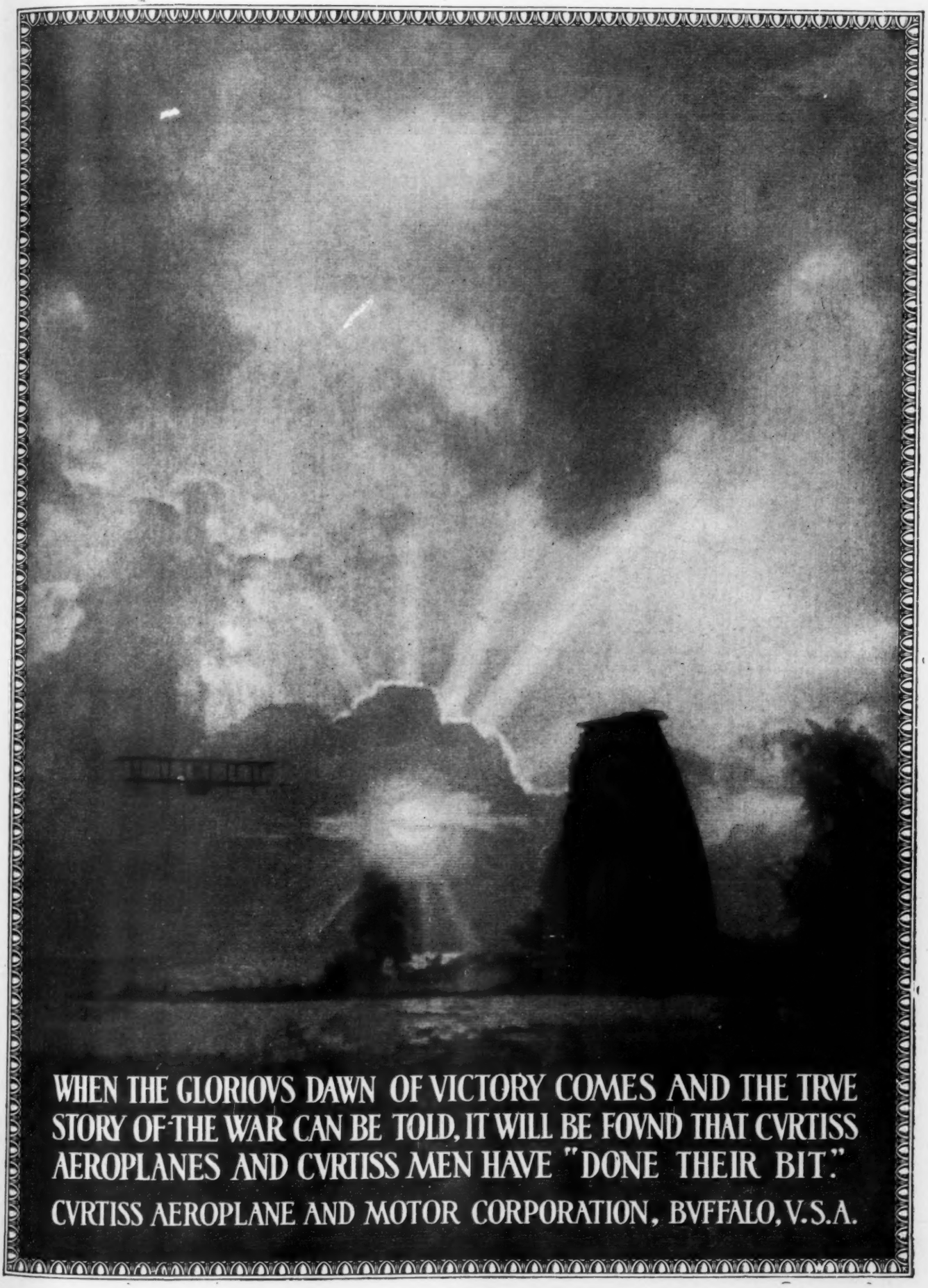
Swedging Stream-Lined Wire

A representative of AVIATION AND AERONAUTICAL ENGINEERING discovered recently at the plant of the Spranger Wire Wheel Corp. at Detroit, Mich., twelve specially designed machines, working on wire for airplanes.

Until recently manufacturers in this country have found it necessary to import stream-lined wire from England as there were few if any machines here capable of doing this class of work. The Spranger Corp. which has been for many years extensively engaged in making wire wheels for automobiles, is at present devoting nearly all its capacity to turning out wheels for airplanes, as it was found that the swedging machine is admirably adapted for this kind of work.

Ferdinand Issues Booklet

L. W. Ferdinand & Co., 152 Kneeland Street, Boston, Mass., manufacturers of marine glues and cements have issued a new twenty-page booklet, entitled "Marine Glue," describing their different products, together with prices.


WHEN THE GLORIOVS DAWN OF VICTORY COMES AND THE TRVE
STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS
AEROPLANES AND CVRTISS MEN HAVE "DONE THEIR BIT."
CVRTISS AEROPLANE AND MOTOR CORPORATION, BVFFALO, V.S.A.

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Have You Seen the New Gillettes Specially Designed for the Fighting Man?

THESE models were designed by members of the Gillette Organization who have seen service with the Colors and know what the soldier is up against.

Hundreds of officers and men are buying them—the U. S. Service Set in metal case, and the new khaki-covered sets for Uncle Sam's soldiers and officers.

The Gillette is the one razor for the man who is doing things—the one razor with world-wide use and reputation.

When a man wants new Blades he can get them at any Post Exchange or Y. M. C. A. Hut—here in America or Overseas.

Our Paris Office carries stocks—is constantly supplying the American Expeditionary Forces. Gillette Safety Razors and Blades on sale everywhere in France, England, Italy and the Eastern battle fronts.

Why do so many of Uncle Sam's Boys use the Gillette?

LET a man spend just one week in the service—then give him free choice of all the makes of razors there are. He'll reach for the Gillette first, and hold on to it—**every time.** There's nothing like seeing the Gillette idea work out in the experience of thousands of men—under extreme conditions.

Here is the No Stropping, No Honing principle—tested and approved by millions of men in the world at peace.

The world goes to war. Millions of men spring to arms—and the one razor that survives the test of war conditions on a world-wide scale is the No Stropping, No Honing Gillette.

There isn't a regiment in the field today under any of the Allied Flags but numbers more users of Gillettes than of all other razors put together. There isn't a condition that a man could find in his shaving—heat, cold, sunburn, wind-chap, water scarce or bad—but has been met by the Gillette thousands of times in its nearly four years of war service.

The fighting man lives in his pack—every inch of space and ounce of weight taken up.

The Gillette tucks away in the corner, or in his pocket—compact, complete—Blades always sharp, always ready—simple, strong, stands the wear and tear—weighs next to nothing—and No Stropping, No Honing.

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Aeronautical Trade Directory
—and—
Index of Advertisers

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of companies listed below.

For Advertisements in this issue refer to page numbers opposite names.

ACCESSORIES AND INSTRUMENTS PAGE

King, Julius, Optical Co.
The Motor Meter Co.
National Gauge & Equipment Co.
O'Hara Waltham Dial Co.
Rieker, Walter.
Sperry Gyroscope Co. 221
Standard Aeronautical Co.
Tayor Instrument Companies.
Western Electric Co.

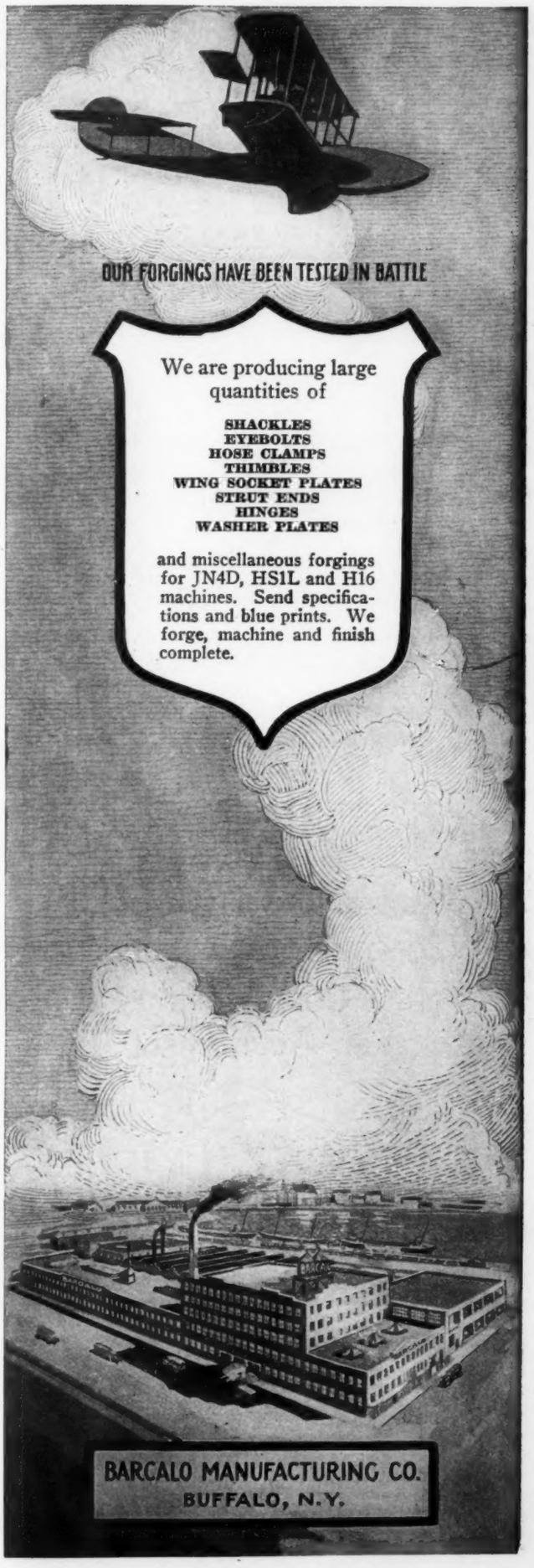
AIRPLANES

Aeromarine Plane & Motor Co.
Blackhawk Airplane Co.
Boeing Airplane Co. 247
Breese Aircraft Corp.
The Burgess Company 204
California Aviation Co.
Chicago Aero Works
Cooper, John D., Aeroplane Co.
Curtiss Aeroplane & Motor Corp. 222-243
Dayton Wright Airplane Co. 268
Des Lauriers Aircraft Corp.
Dewey Aeroplane Co.
Engel Aircraft Co.
Falcon Mfg. Co.
Fisher Body Corp.
Fowler Airplane Corp.
Gallaudet Aircraft Corp.
Heinrich, A. S., Corp.
Lanzius Aircraft Co. 250
Lawrence-Lewis Aeroplane Co.
Lawson Aircraft Corp.
Lewis & Vought Corp.
Loening Aeronautical Engineering Corp.
Longren Aeroplane Co.
L. W. F. Engineering Co 205
Martin, Glenn L., Co 202
Michigan Aircraft Corp.
Ordnance Engineering Corp. 248
Patterson Aeroplane Co.
Pierce, Samuel S., Aeroplane Corp.
Smith, Kyle, Aircraft Co.
Sperry, Lawrence, Aircraft Co.
Springfield Airplane Co.
Standard Aircraft Corp. 262
Sturtevant Aeroplane Co.
Thomas-Morse Aircraft Corp. 263
Walden-Hinners Co. 263
The Willys-Morrow Co.
Wittemann-Lewis Aircraft Co.
Wright-Martin Aircraft Corp. 206

AIRPLANE ENGINES

Aeromarine Plane and Motor Co.
Ashmusen Mfg. Co.
Continental Motors Co.
Curtiss Aeroplane & Motor Corp. 222-243
Dayton Aero Motors Co.
Detroit Gas Turbine Corp.
Duesenberg Motor Corp. 207
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
Hall-Scott Motor Car Co 203
Kemp Machine Works
Kessler Motor Co.
Knox Motors Co.
Nordyke & Marmon
Packard Motor Co.
Roberts Motor Mfg. Co.

(Continued on page 247)



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(Continued from page 245)

PAGE

Rolls-Royce, Ltd.
Springfield Motors Co.
Sterling Engine Co.
Sturtevant, B. F., Co.
Trego Motors Corp.
Thomas-Morse Aircraft Corp. 263
Union Gas Engine Co. 208
Van Blerck Motor Co.
Willys-Overland Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp. 206

AIRPLANE PARTS

Aircraft Parts Mfg. Co.
American Body Co.
Astoria Veneer Mill & Dock Co.
Barcalo Mfg. Co. 245
Century Telephone Construction Co.
Chicago Aeronautical Supply Co.
Dayton Metal Products Co. 217
Erie Specialty Co 251
Kawneer Mfg. Co.
Levett, Walker M., Co. 209
New Jersey Veneer Co. 264
Pressed & Welded Steel Products Co.
Rogers Construction Co.
Standard Parts Co.
Welch Mfg. Co.
Willys-Morrow Co.
Wilson Cabinet Co.

ALUMINUM

Acieral Co. of America
Aluminum Castings Co. 211
Aluminum Co. of America 258
American Metal Co., Ltd.
Levett, Walker M., Co. 209
Leygrand & Co. 264
McAdamite-Aluminum Co.
So-Luminum Mfg. & Eng. Co. (Solder) 264
Stimpson, Edwin B., Co. 248
United Smelting & Aluminum Co.

AVIATION SCHOOLS

American School of Aviation
America Trans-Oceanic Co.
Atlantic Coast Aeronautical Station 222-24
Beam Airplane Co.
Blackhawk Airplane Co.
Curtiss Training Schools 222-24
Eagle Aviation School
The Hydrerocraft Co.
Michigan State Auto School.
Moler Aviation Instructors
Penn. State School of Aero-Mechanics
Stinson School of Aviation

BALL BEARINGS

The Fafnir Bearing Co. 212
Gurney Ball Bearing Co.
The Gwilliam Co.
Hess-Bright Mfg. Co. 267
New Departure Mfg. Co.
Norma Company of America 220
S K F Ball Bearing Co. 214
U. S. Ball Bearing Mfg. Co.

BALLOONS: DIRIGIBLES

Burdette Oxygen Co.
Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
Gas Engineering Co. (Gas Plants)
Goodyear Tire and Rubber Co.
Janney-Steinmetz & Co.
United States Rubber Co. 246

BAROGRAPHS AND BAROMETERS

Green, Henry J.
Haustetter, A. 249
Sussfield & Lorch
Taylor Instrument Companies

(Continued on page 249)

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AIRCRAFT

(Continued from page 247)

BEARING METALS

PAGE

American Bronze Co.
Fahrig Metal Co. 256
Levett, Walker M., Co. 209
Magnolia Metal Co.

BUSHINGS

Bound Brook Oil-less Bearing Co.

CARBURETORS

H. & N. Mfg. Co.
Master Carburetor Co.
Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler & Schebler
Zenith Carburetor Co. 264

CLOCKS AND WATCHES

Chelsea Clock Co.
Depollier, J., & Son.
Ingersoll, Robert H., & Bros.
Waltham Watch Co.

CLOTHING

Abercrombie & Fitch
Cross, Mark
Lee, H. H., Mercantile Co.
N. Y. Sporting Goods Co.
Rainwear Co.
Rogers, Peet & Co.
Sanders Company
Spalding, A. G., & Bros.

COMPASSES

Sperry Gyroscope Co. 221
Star Compass Co.
Taylor Instrument Companies

DOPE AND VARNISH

Adams & Elting Co.
American Emaillite Co.
Brooklyn Varnish Mfg. Co.
Chemical Products Co. 249
Conover, The C. E., Co.
Du Pont Chemical Works
Flexible Compound Co.
Harland, Wm., & Son
Lucas, John, Company
Masury, John W., & Son
National Aeroplane Co.
Perry-Austen Company
Pratt & Lambert
Smith, Edward, & Co.
Standard Varnish Works
Valentine & Company
Weeks & Co.

DRIFT INDICATOR

Sperry Gyroscope Co. 221

DRY KILNS

Cutler Dry Kiln Co.
Grand Rapids Veneer Works 259

DYNAMOMETER

Sprague Electric Works

ENGINE PARTS

Allegheny Forging Co.
Aluminum Castings Co. 211
Anderson Forge & Machine Co.
Barcalo Mfg. Co. 245
Burd High Compression Ring Co.
Crosby Steam Gage & Valve Co.
Dallet, Thos. H., Co.
Doehler Die Casting Co. 266

(Continued on page 251)

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(Continued from page 249)

PAGE

Erie Specialty Co.....251
Fibre Finishing Co.
Gifford, Leland Co.
Gill, P. H., & Sons
Hayes Mfg. Co.
Hydraulic Pressed Steel Co.
Levett, Walker M., Co.....209
Meisel Press Mfg. Co.
Park Drop Forge Co.....260
Pressed & Welded Steel Products Co.
Standard Parts Co.
Stimpson, Edwin B., Co.....248
Taft-Peirce Mfg. Co.
Tioga Steel & Iron Co.....266
Williams, J. H., & Co.
Whitman & Barnes Mfg. Co.....248
Wyman-Gordon Co.....220

ENGINEERING

Automotive Engineering Co.....248
Ordnance Engineering Co.....265
White, J. G., Engineering Corp.....216

FABRICS

Courtrai Mfg. Co.
Hutchinson, Scott Co.
Lamb, Finlay & Co.
McBratney, Robt., & Co.....266
Whitman, Clarence & Co.

FELT

Advance Felt Specialty Co.
Booth Felt Co.....268
Western Felt Works

FIRE EXTINGUISHERS

Fyr-Fyter Co.
Johns-Manville, H. W., Co.
Pyrene Mfg. Co.

GAGES

Boston Auto Gauge Co.....255
Crosby Steam Gauge & Valve Co.
Foxboro Co., Inc.....248
Greenfield Tap & Die Corp.
United States Gage Co.

GASKETS

Fibre Finishing Co.

GLUE

Armour Glue Works
Baeder & Adamson
Ferdinand, L. W., & Co.....265

GOGGLES

Harly, F. A. Co.....251
Meyrowitz, E. B.
Strauss & Buegeleisen.....219
Strong, Kennard & Nutt
Willson, T. A., & Co., Inc.

HANGARS

American Bridge Co.
Anchor Corrugating Construction Co.
Ashley Steel Bldg. Co.
Austin Co., The
Barney, John M.
Howell, Field & Goddard, Inc.
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Chetham Lumber Co.
Delatour, J.
Dutton, A. C., Lumber Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.
N. J. Veneer Co.....264
Sheip & Vandegrift.....250

(Continued on page 253)

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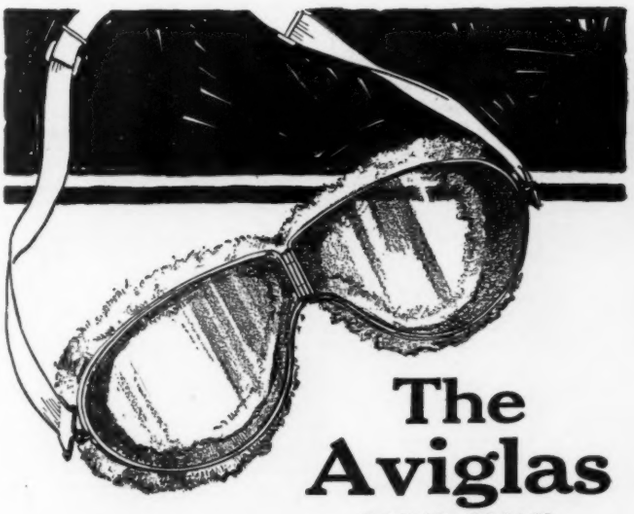

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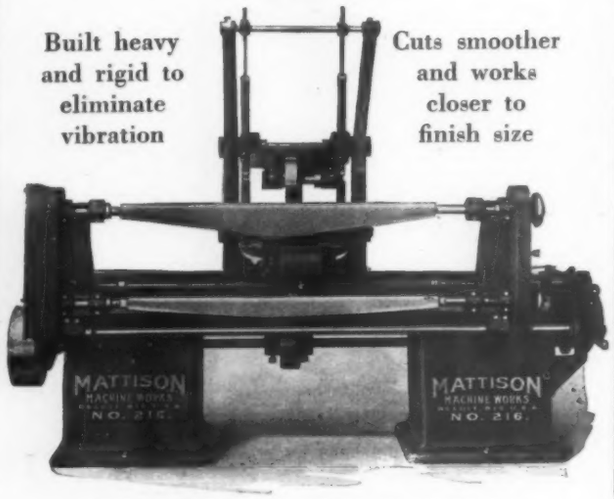

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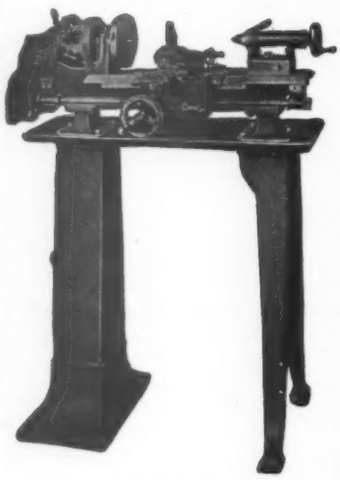

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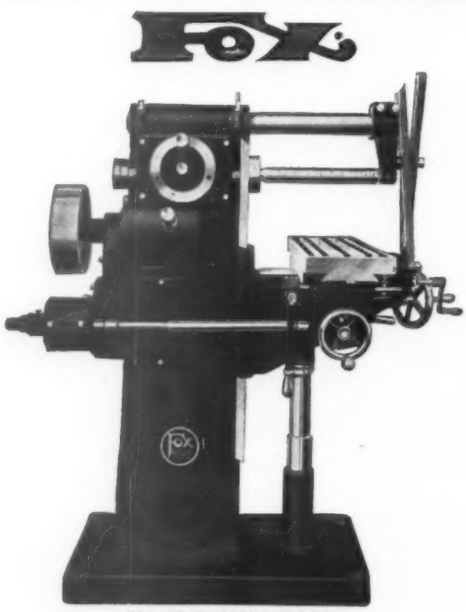

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(*Continued from page* 251)

LUMINOUS COMPOUND — PAGE

Cold Light Mfg. Co. 246
Cummings, W. L., Chemical Co.
Radium Dial Co. 261
Radium Luminous Material Corp 253

MACHINERY, METAL WORKING

Dalton Mfg. Corp. 252
Defiance Machine Works 252
Fox Machine Co. 252
Warner & Swasey Co.

MACHINERY, WOODWORKING

Defiance Machine Works 252
Fox Machine Co. 252
Machinery Merchants, Inc.
Mattison, C., Machine Works 252
Olney & Warrin
Pryibil, P., Machine Co 259

MAGNETOS

Berkshire Magneto Corp.
Bosch Magneto Co.
Ericsson Mfg. Co.
Remy Electric Co.
Splitdorf Electrical Co.

MANIFOLDS

Ajax Auto & Aero Sheet Metal Co. 254
Pressed & Welded Steel Products Co.

METALS

Acieral Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Betz-Pierce Co., The 215
Detroit Pressed Steel Co.
Federal Pressed Steel Co.
Garland Ventilator Co.
Gueder, Paeschke & Frey Co.
Kawneer Mfg. Co.
La Salle Steel Co.
Levett, Walker M., Co. 209
Rumford Metal Co.
So-Luminum Mfg. & Eng. Co. 264
Steel Sales Corp.
Standard Alloys Co.
Stimpson, Edwin B., Co. 248
Wheeler, Frank H., & Son

MODEL AIRPLANES

Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg. Supply Co.
Hendee Mfg. Co. 258
Harley-Davidson Co.
Militare Motor Vehicle Co. of America

OILS AND LUBRICANTS

Baker Castor Oil Co. 253
Graphite Lubricant Co.
Gulf Refining Co.
Sheppard Ideal Oil Co.
Sun Co., The
Standard Oil Co.
Swan & Finch.
Texas Co., The
Vacuum Oil Co.

PACKING

Fibre Finishing Co.

PHOTOGRAPHY

Brock, Arthur, Jr. 258
Herbert & Huesgen Co.

PISTONS

Levett, Walker M., Co. 209

PISTON RINGS

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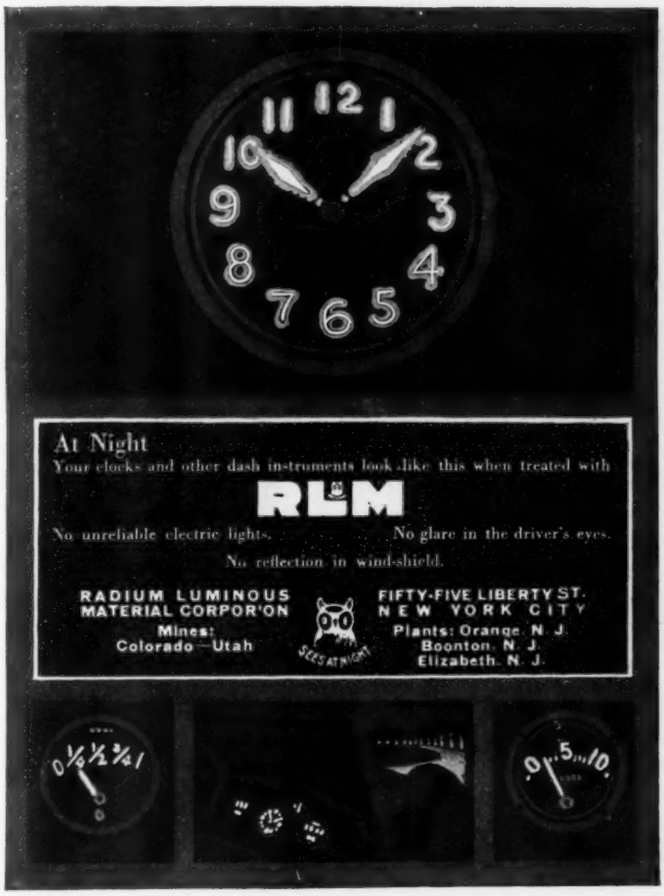
(*Continued on page* 255)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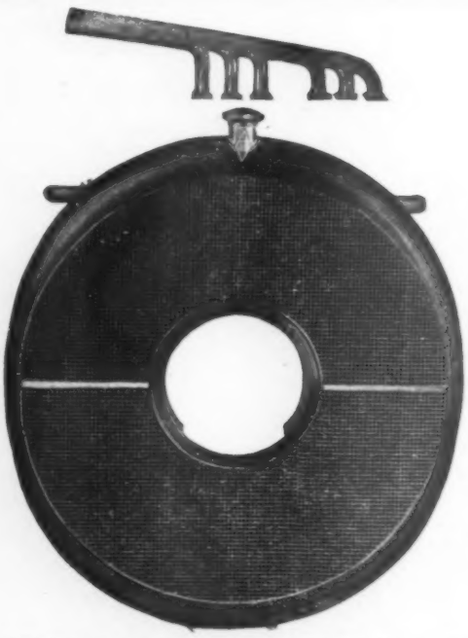

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(Continued from page 253)

PONTOONS

Niagara Boat Co.
Palmer-Simpson Co......265
Welin Marine Equipment Co.

PROPELLERS

American Propeller & Mfg. Co......265
American Sash & Door Co.
Aviauto Mfg. Co.
Breitung & Co., Ltd.
C. M. O. Physical Laboratory
Doyle, W. A......264
Hartzell Walnut Propeller Co......266
Lang Propeller Co. of America
Steves Sash & Door Co.
Reinforced Propeller & Insulating Co., The
United States Aero Propeller Co......261
Washington Aeroplane Co.
West Woodworking Co......255

PYROMETERS

Foxboro Co., Inc., The.....248
Moto-Meter Co.
Shore Instrument & Mfg. Co.
Taylor Instrument Companies

RADIATORS

Ajax Auto & Aero Sheet Metal Co......254
A-Z Co.
Bush Mfg Co.
El Arco Radiators Co.
English & Mersick Co.
Flexo Mfg. Co......254
Livingston Radiator Co......213
McCord Mfg. Co.
Rome-Turney Radiator Co.....254

RIVETS

Stimpson, Edwin B., Co......248

SCELEROSCOPE

Shore Instrument & Mfg. Co.

SHEET METAL FITTINGS

Rogers Construction Co.

SHOCK ABSORBERS

Dural Rubber Corp......247
General Rubber Goods Co.
Russell Mfg. Co......265
Wood, J. W., Elastic Web Co.....256

SPARK PLUGS

Bosch Magneto Co.
Champion Ignition Co.
Johns-Manville, H. W., Co.
Rajah Auto Supply Co.
Silvex Co., The
Splitdorf Electrical Co.

SPEED INDICATORS

Foxboro Co., Inc......248
Johns-Manville, H. W., Co.
Stewart-Warner Speedometer Corp.

STABILIZERS

Greene Aeronautical Co.
Martin Aerodynamic Stabilizer
Sperry Gyroscope Co......221

STAMPINGS

Lansing Stamping & Tool Co......264
Dewes, The A., Co......266
Stimpson, Edwin B., Co.....248

STARTERS

Bijur Motor Lighting Co.
Bosch Magneto Co.
Christensen Engineering Co., The
Dayton Engineering Laboratories Co.
Motor-Compressor Co......265
Northeast Electric Co.
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(Concluded on page 257)

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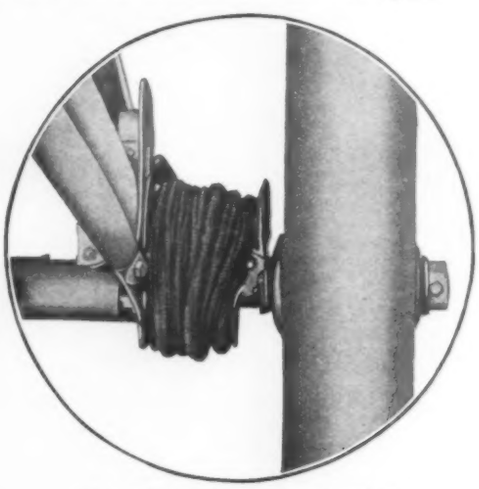

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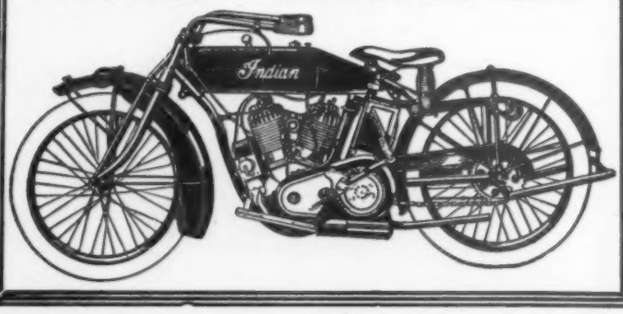

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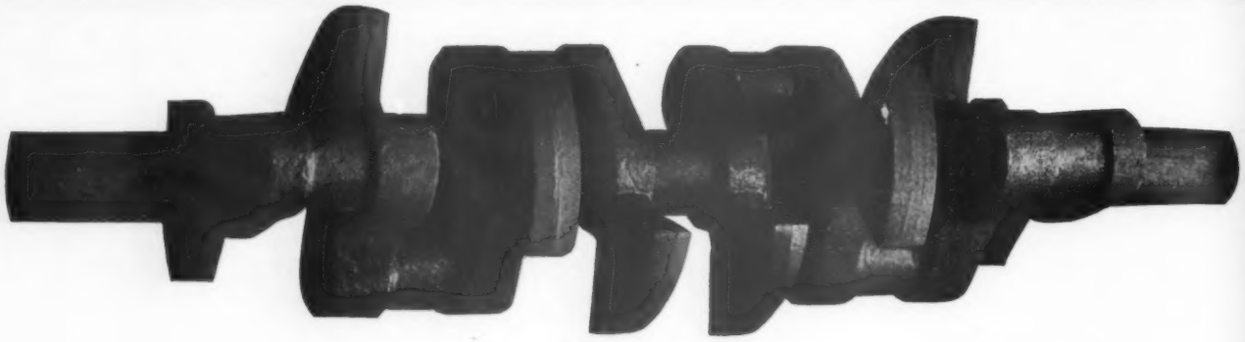

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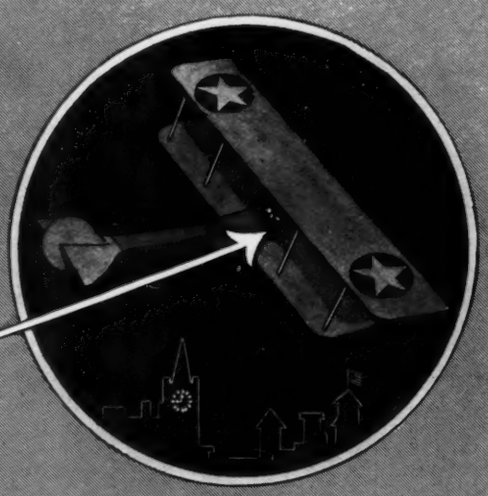

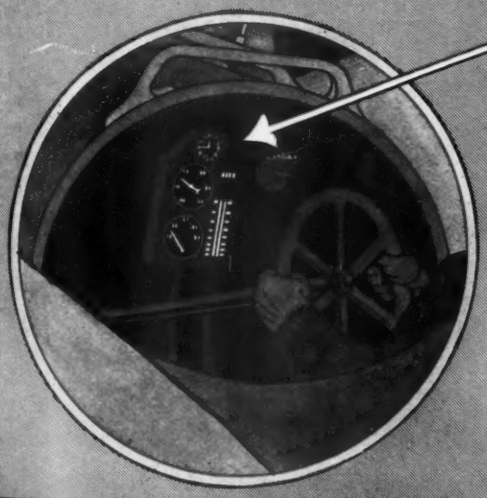

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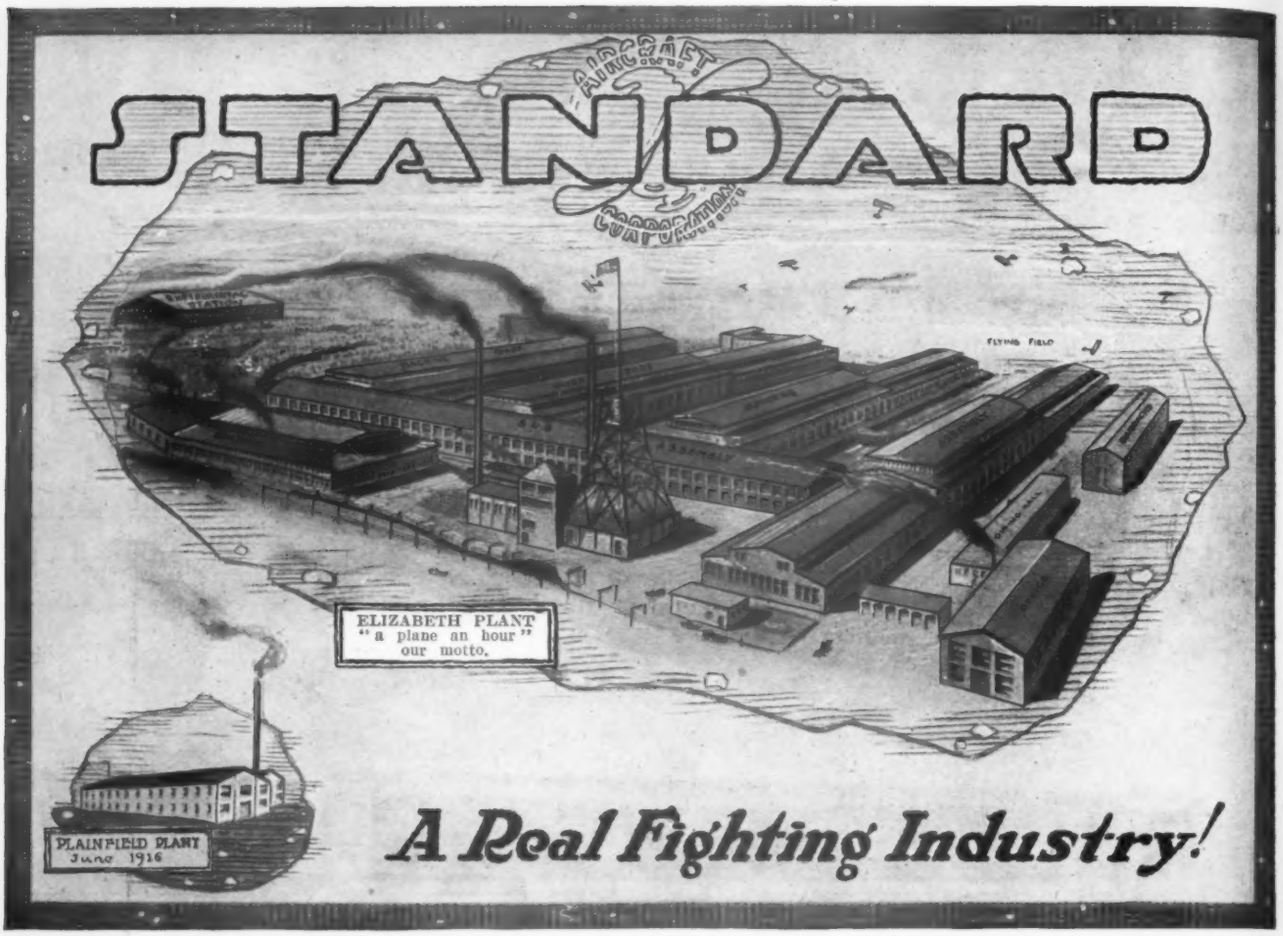

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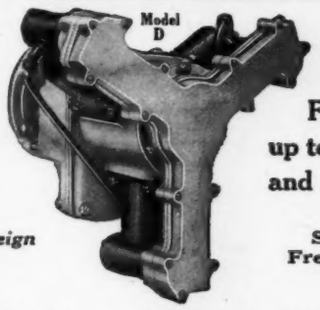

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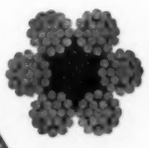

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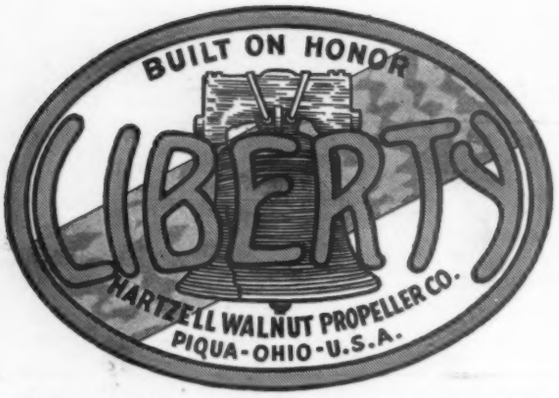

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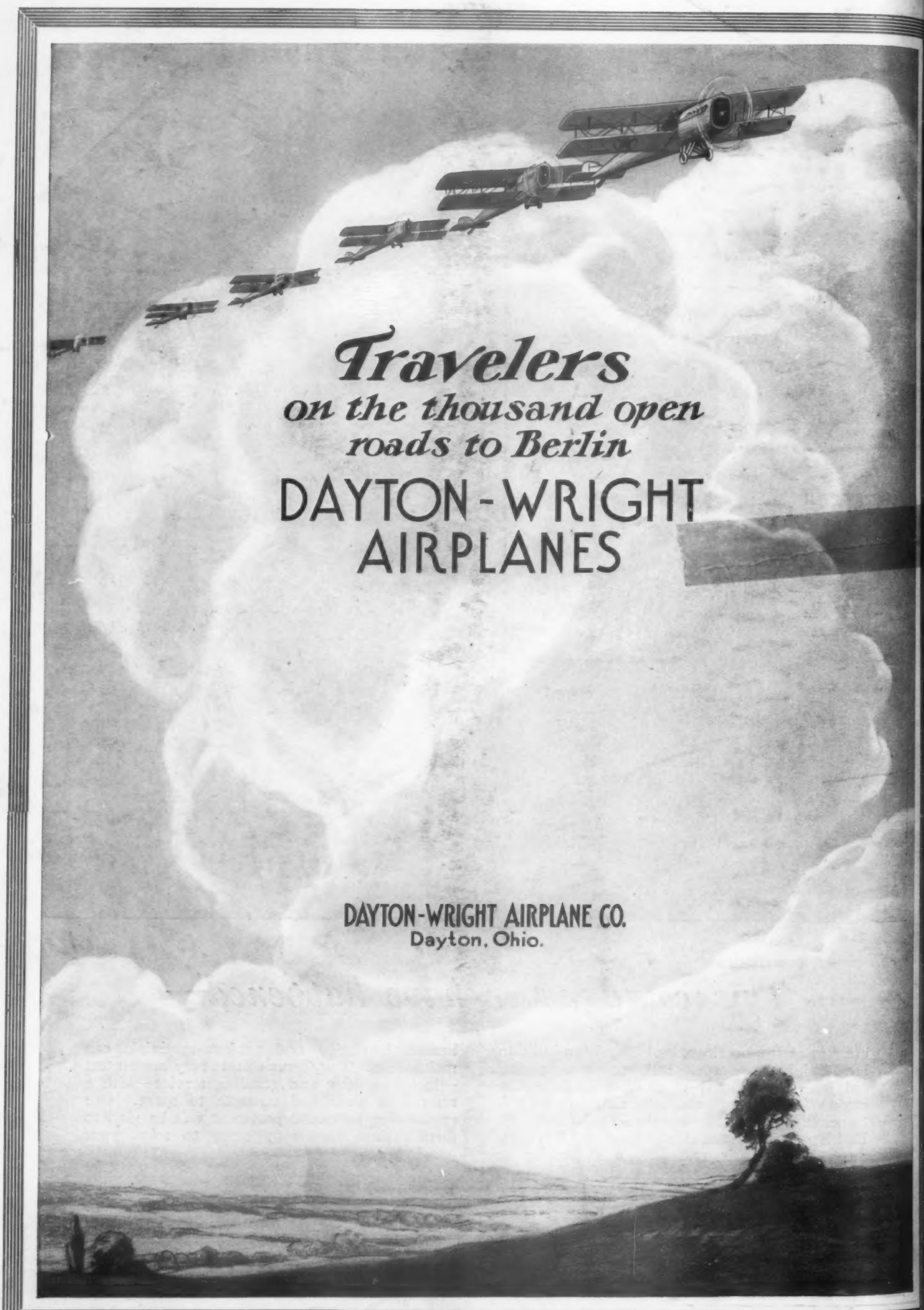
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